PHILIPS

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Manual

PORTABLE OSCILLOSCOPE
PM 3200
PM 3200 X

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1/1069/1/03 > D5601/04

IMPORTANT!

In correspondence concerning this apparatus always state the type number and the serial number as indicated on the type plate of the apparatus.

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GENERAL

1 Introduction

The portable oscilloscope PM 3200 can operate both from the mains and from rechargeable batteries. The Y-amplifier has been provided with a drift compensation network; the internal time base generator operates automatically to a high extent and external triggering is also possible. The PM 3200 can also be used as an X-Y oscilloscope over a certain frequency range. Except for the input stage and the CRT the instrument is fully transistorised.

Fig. 1. Front view of PM 3200

II Technical data

Vertical amplifier

Frequency range	d.c. coupled 0... 10 MHz (—3 dB) a.c. coupled 2 Hz... 10 MHz (—3 dB)
Rise time	35 ns
Deflection coefficient	2 mV per division to 50 V per division in 14 calibrated steps (sequence 1, 2, 5)
Accuracy (overall)	± 5%
Input impedance	1 MΩ//30 pF
Max. input voltage	400 V (d.c. voltage + peak value of alternating voltage)
Max. deflection	For sinusodial signals with frequencies up to 1 MHz the vertical deflection is undistorted for a total amplitude corresponding to 24 divisions; all the 8 successive divisions can be displayed.
Voltage for adjusting the measuring probe	Squarewave voltage (0.25 V superimposed on approx. 1 V d.c.; non-calibrated)

Time base generator

Sweep times and accuracy	0.5 - 0.2 - 0.1 sec/div	(± 7%)
	50 - 20 - 10 ms/div	(± 5%)
	5 - 2 - 1 ms/div	(± 5%)
	0.5 - 0.2 - 0.1 ms/div	(± 5%)
	50 - 20 -10 µs/div	(± 5%)
	5 - 2 - 1 µs/div	(±5 %)
	0.5 - 0.2 - 0.1 µs/div	(± 7%)

Triggering Trigger facilities	The time base generator operates only in the triggered mode when a signal is present. If no signal is present the time base generator is automatically free-running. The trigger level is derived from the input signal.

Trigger source	To be selected by means of a switch: INT (vertical amplifier) EXT (external source) LINE (voltage of mains frequency)
Trigger system	Automatic
Trigger sensitivity (In position "MEAN")	INT. 1 division from 10 Hz to 1 MHz 2 divisions from 1 MHz to 10 MHz EXT. 1 V_{p-p} from 10 Hz to 1 MHz 2 V_{p-p} from 1 MHz to 10 MHz
Trigger level	Can be selected by means of a switch: MEAN (triggering on mean value of a.c. signal) TOP (triggering on peak value) HF rej. (same as MEAN but via a low-pass filter and a demodulator)
Max. voltage for external trigger input	400 V (d.c. voltage + peak value of alternating voltage)
Impedance of external trigger input	0.1 MΩ//25 pF
External trigger voltage control	continuously variable
Horizontal amplifier	
Frequency range	10 Hz... 100 kHz (—3dB)
Deflection coefficient	continuously adjustable between 300 mV/div and 50 V/div
Input impedance	0,1 MΩ//25 pF
Max. input voltage	400 V (d.c. voltage + peak value of alternating voltage)
Cathode ray tube	
CRT	10 cm tube with 1.5 kV acceleration voltage
Tube type	D10 - 16 GH (P31) medium-short persistence, green. GM (P7) optionally available. (PM 3200 G)
Max. deflection	vertical up to 8 divisions horizontal up to 10 divisions

Size of 1 division	7.5×7.5 mm
Power supply	
Mains voltages	110 - 125 V or 200 - 250 V (selector switch) 127 V ± 10% (resoldering) 40 - 400 Hz; 20 VA.
For 110 V only:	PM 3200Q (U.S.A. Version) PM 3200R (C.S.A. approved version, file number LR 20891)
External direct voltage source	22 - 30 V; 0.6 A
Battery supply	See accessoires.
Dimensions	17.5 cm high, 21 cm wide, 33 cm long
Weight	5.3 kg.
NATO stock number	6625 - 17 - 804 - 2838

III Accessories

Accessories supplied with the instrument:

1 × adapter PM 9051 (BNC — 4 mm)
1 × operating instructions
1 × manual

Optinal accessories

Probe set with 1.15 m lead	:	PM 9326
Probe set with 2 m lead	:	PM 9327
Battery case (empty)	:	PM 9390
Battery case with batteries	:	PM 9391
Adapter for external 24 V d.c. supply	:	PM 9392
Carrying case	:	PM 9393
Rack mount kit	:	PM 9360

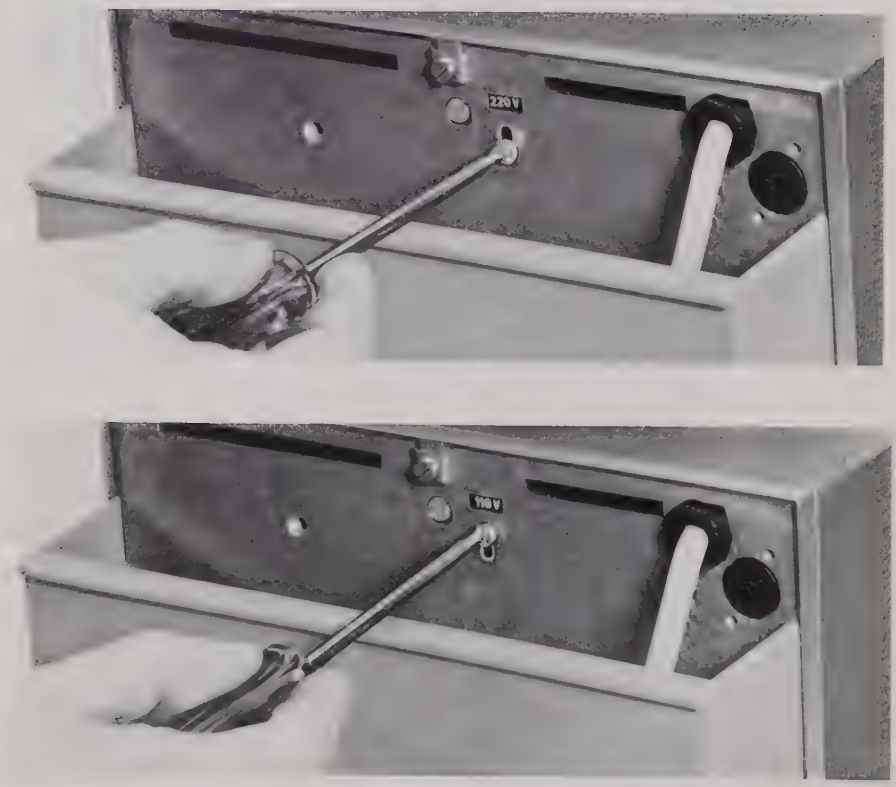


Fig. 2. Mains voltage 220V and 110V

DIRECTIONS FOR USE

IV Installation

A. ADJUSTING TO THE LOCAL MAINS SUPPLY

On delivery the instrument is adjusted to a mains voltage of 200-250 V (220 V nominal). When the mains voltage is 100-125 V (110 V nominal) the mains voltage selector at the rear should be set accordingly Fig. 2. Additionally a resistor (82Ω; 10%; 5½ W Ordering no. 4822 112 20078) should be included in the blue wiring when connecting the instrument to a 127 V (± 10 V) supply (Fig. 3).

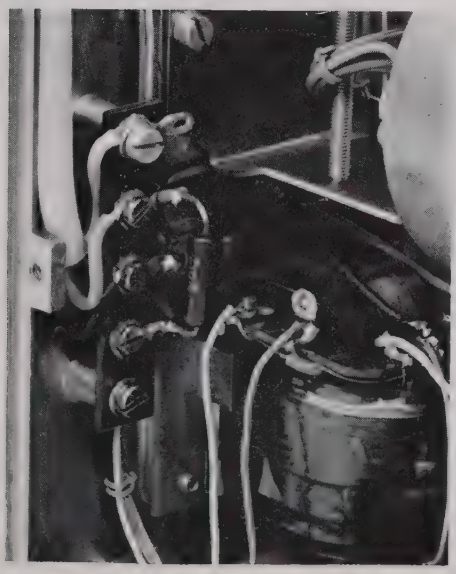


Fig. 3. Preparing for a 127 V mains supply

B. EARTHING

The instrument should be earthed in accordance with local safety regulations. This may be effected:

1. via the earthing socket at the front of the instrument
2. via the measuring lead (earthing wire with alligator clip)
3. via the earthing screw near the mains voltage selector
4. via the mains lead (3-core).

Double earthing connections should be avoided, as this may give rise to hum.

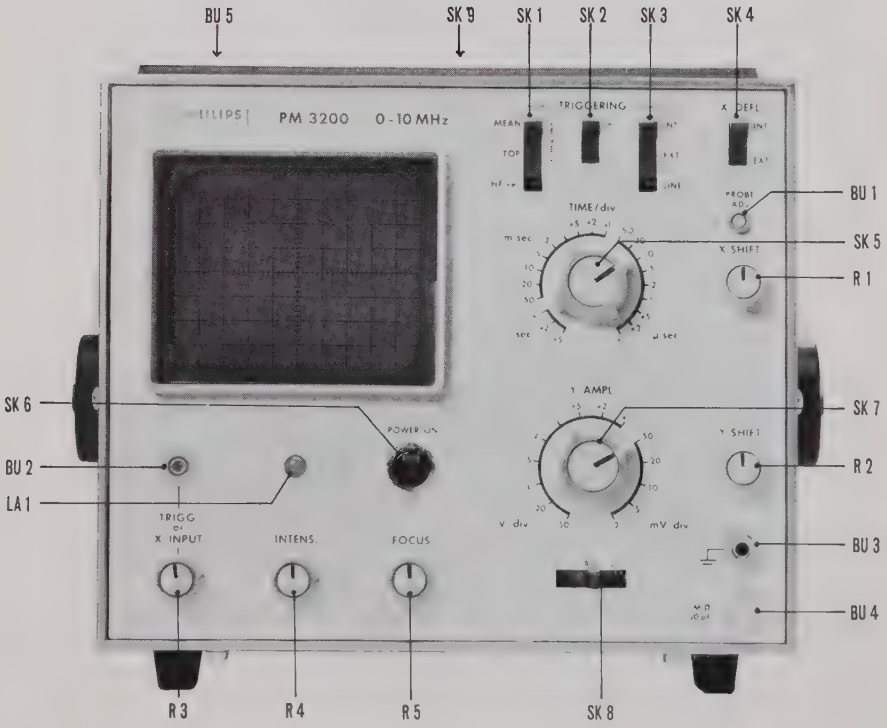


Fig. 4. Controls

V Operation

A. CONTROLS, SOCKETS AND THEIR FUNCTIONS

For the functions and location of the controls and sockets, see Fig. 4.

BU1 Output terminal for test voltage
BU2 Input socket for external trigger voltage, or X deflection voltage
BU3 Earthing socket
BU4 Input socket for Y deflection voltage
BU5 Input socket for d.c. supply (at the rear of the instrument)
(BU6) Interconnection plug, when BU5 is not used
LA1 Pilot lamp
R1 Horizontal shift
R2 Vertical shift
R3 Input attenuator for external triggering or X deflection
R4 Brightness control
R5 Focusing of the electron beam
SK1 Selector for trigger level
SK2 Selector for trigger polarity
SK3 Selector for trigger source
SK4 Selector for X deflection
SK5 Selector for sweep times
SK6 Mains switch
SK7 Attenuator switch
SK8 Selector for coupling Y amplifier input
SK9 Mains voltage selector

B. DISPLAYING WAVEFORMS

1. Time base line

- Set all toggle switches to the upper position.
- Set R1, R2 and R5 to the mid-position.
- Turn R3 and R4 anti-clockwise.
- Switch on the instrument with SK6 (LA1 should light up).
  After approx. 20 sec. the instrument is ready for operation.
- Turn R4 slowly clockwise until the trace has the desired intensity.
- If required, adjust R5 for max. sharpness.

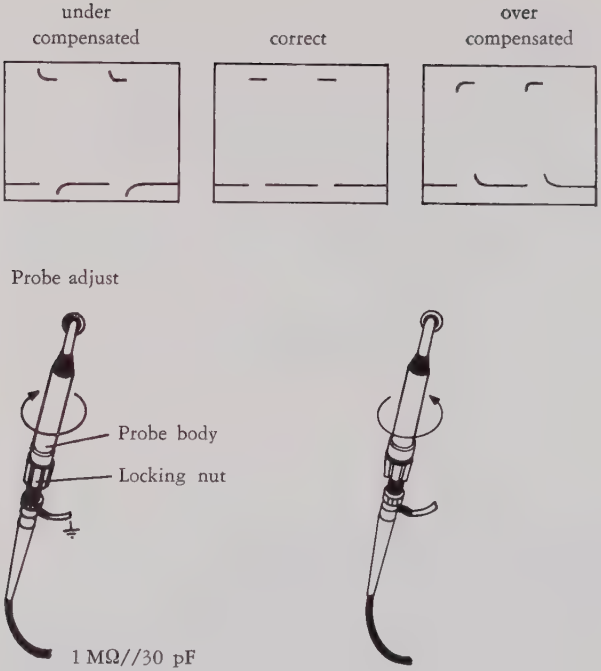


Fig. 5. Adjustment of attenuator probe

2. Adjustment of attenuator probes PM9326 or PM9327

- Display a time base line in accordance with B1.
- Set SK3 to position "LINE" or in case of battery supply, trigger the instrument externally in accordance with D.
- Set SK8 to position "AC", and SK7 to position "5 mV/div".
- Connect the measuring lead to BU4 and place the tip of the attenuator probe on BU1 (see Fig. 5).
- Select a suitable time base value with SK5.
- Loosen the "locking screw" and turn the "probe body" with respect to the cables until correct adjustment is obtained.
- Secure the locking nut without changing the adjustment (check!).

3. Input circuit

The signal to be measured, which is applied to BU4, is applied direct to the Y amplifier (SK8 in position "D.C.") or via a capacitor (SK8 in position "AC") in order to suppress d.c. components.
When SK8 is in position "0", BU4 is disconnected and the input of the Y-amplifier is connected to earth in order to determine the zero level of the screen trace.

C. TRIGGERING (internal)

When the signal to be measured, which is applied to BU4, causes a sufficiently high Y deflection, triggering takes place automatically if SK4 is in position "INT".

- Start with SK1... SK4 in the upper position.
- Select a suitable time base setting with SK5.
- Select the desired trigger moment with SK2; "+" for triggering on a positive-going edge, or "–" for triggering on a negative-going edge.
- If the signal to be measured is locked to the mains frequency, triggering on the mains frequency is possible with SK3 in position "LINE" (e.g. for comparing phase shift; reversal of the contact plug causes a 180° phase shift).
- Large duty cycles of pulse-shaped signals may sometimes give rise to difficulties. In that case SK1 should be set to position "TOP".
- H.F. components may sometimes give rise to a blurred image (jitter). These components can be removed by setting SK1 to position „HF rej".

Note: In case of sinewave signals of a relatively high frequency the transit time of the unblaking amplifier and that of the trigger amplifier will play apart so that in position "MEAN" of SK1 the beginning of the trace will be shifted towards the top and in position „TOP" the beginning will be shifted towards the middle of the sinewave.

D. TRIGGERING (external)

- Apply the signal to be measured to BU4.
- Apply the trigger signal to BU2.
- Set SK3 to position "EXT".
- Select a suitable level and polarity with SK1 and SK2.
- Set R3 to a position, as far as possible anti-clockwise, at which triggering is stable.

E. X-Y DEFLECTION

- Apply the signal for X-deflection to BU2 and the signal for Y-deflection to BU4.
- Adjust for suitable deflection with R3 and SK7.

Note: As the X and Y amplifiers are not identical, phase shifts may occur (open loop) at higher frequencies.

SERVICE DATA

VI Circuit description

A. POWER SUPPLY

1. Rectifier

Transformer T401 has been provided with two primary windings, which, by means of SK9 at the rear of the instrument, can be connected in series or in parallel for mains voltages of 220 V or 110 V nominal. The secondary voltage of approx. 25 V_{rms} supplies the instrument via rectifier GR401 or may be used for charging the accummulator batteries when employing battery case PM9391.

Via a control circuit the direct voltage, obtained from the rectificier or from the batteries or another direct voltage source, is applied to a d.c. converter, which provides the various supply voltages.

A potentiometer circuit delivers part of the secondary alternating voltage to the trigger amplifier as a trigger signal.

2. Control circuit

The control circuit has a series regulator TS402, the load being included in the collector circuit and the reference voltage (across zener diode GR403 and silicon diode GR402) being derived direct from the output voltage. In order to reduce the dissipation of the regulating transistor in case of short-circuits, the base current of this transistor should be reduced.

This is effected, via the circuit with transistors TS403 and TS404, when transistor TS401 becomes conductive.

TS401 starts conducting at an output current of approx. 900 mA, when the voltage drop across R406 exceeds a certain value.

In order to compensate for temperature influences, NTC-resistor R407 has been connected in parallel with R406.

For starting the circuit, when the instrument is switched on, transistors TS402 and TS403 should be driven into full conduction. This happens because a voltage drop arises across R412 due to the charging of capacitor C402. When trying to switch on the instrument by slowly increasing the

supply voltage before the control circuit, the charging current mentioned above might be insufficient, so that the control circuit could not become operative. After a short-circuit, the instrument should remain off for approx. 1 min. to allow C402 to discharge sufficiently so that the control circuit can become operative again.

3. D.C. converter

The d.c. converter may be compared with a bridge rectifier acting in the opposite direction.
The voltage between the collectors of TS409, TS407 and TS408, TS406 is sinewave shaped. Its frequency (approx. 16 kHz) is determined by the self-inductance and capacitance of the winding of oscillator coil L407 and capacitor C405.
The voltages across windings 3-4 and 5-6 determine which transistors of the bridge circuit are driven into conduction, i.e. TS408 and TS407 or TS406 and TS409 simultaneously. The transistors are driven so that they are bottomed. Due to the presence of L401 this will, nevertheless, give rise to sinewave voltages across L407. Thus it is achieved that the dissipation in transistors TS406... TS409 is very low so that the converter efficiency is very high without the presence of squarewave voltages across oscillator coil L407. This is favourable in view of interference voltages caused by this transformer.
The alternating voltage generated in the secondary winding, is taken from various taps and is then rectified and smoothed. The –1500 V voltage is obtained via a voltage doubler.
A separate winding supplies the heater of the CRT.

B. Y-DEFLECTION

1. Introduction (see block diagram, Fig. 6)

Step control of the deflection coefficient effected both by means of an input attenuator and by controlling the gain factor of the Y amplifier. This permits the application of an input attenuator of a simple design so that a proper transient response can be achieved.
Gain control of the amplifier takes place at low ohmic level so that frequency compensation is not necessary. Moreover, the noise component of the Y amplifier in the less sensitive positions is minimised. If the complete

attenuation would take place before the Y amplifier, the noise component of the amplifier would have an unfavourable value in all positions of SK7.

2. The input circuit

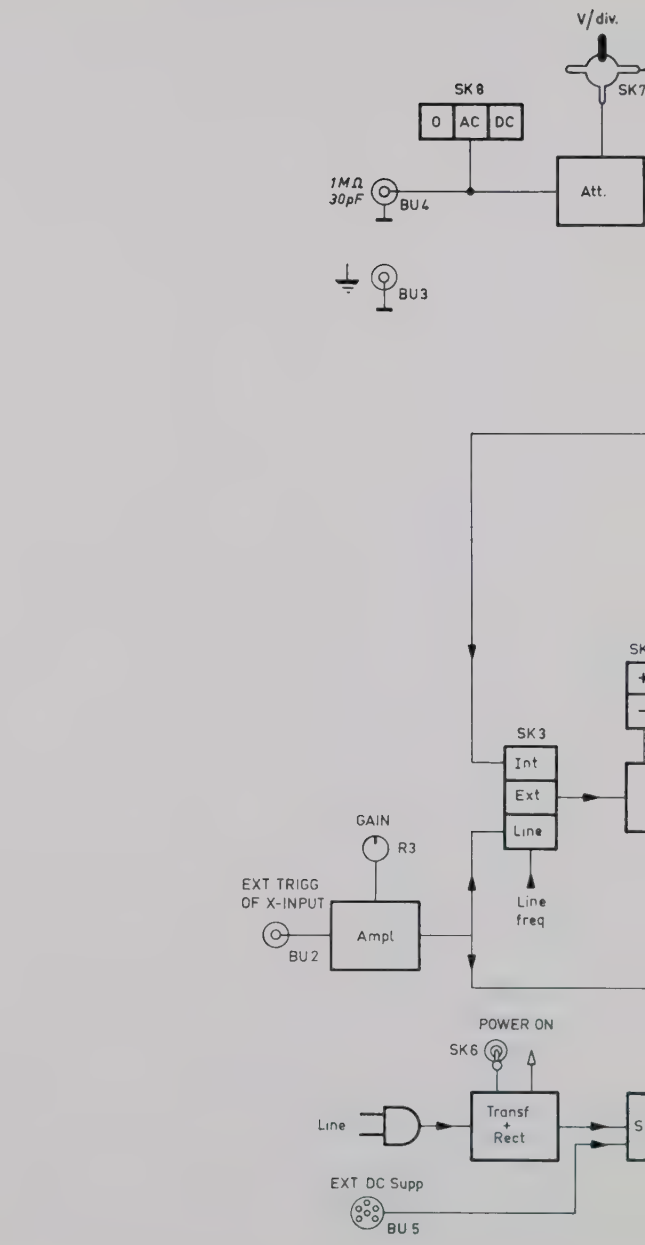
The signal to be measured, applied to BU4 (1 MΩ//30 pF) is applied to input attenuator SK7 via SK8 either direct (DC) or via an isolating capacitor (AC).
When changing over from AC to DC the isolating capacitor is discharged. In position "0" the signal is disconnected and the input of the following circuits is earthed. After passing switch SK8 the signal reaches the input attenuator whose attenuation is as given in the following table.

Position SK7	*Text plate indication*	*Attenuation*
1, 2, 3	50, 20, 10 V/div	1000x
4, 5, 6	5, 2, 1 V/div	100x
7, 8, 9	0.5, 0.2, 0.1 V/div	10x
10, 11, 12, 13, 14	50, 20, 10, 5, 2 mV/div	1x

3. Y-amplifier

The input stage is formed by cathode follower B26' which, via emitter follower TS26, passes the signal on to the next stage. Two diodes protect the base circuit of TS26 against overloading. The following stage consists of series fed-back transistors TS27 and TS29, whose output current is applied to parallel fed-back transistor TS31.
The overall gain of this stage is mainly given by the ratio of the parallel feed-back resistance and the series feed-back resistance, which can be selected. In position 14 of SK7 the series feed-back resistance is minimum. R63 should be adjusted in this position. The overall gain up to TS31 is for the various positions:

Position SK7	*Text plate indication*	*Gain*
10	50 mV/div	2x
11	20 mV/div	5x
12	10 mV/div	10x
13	5 mV/div	20x
14	2 mV/div	50x


V/div.
SK8
0
AC
DC
SK7
1MΩ
30pF
BU4
Att.
BU3
SK3
Int
Ext
Line
GAIN
R3
EXT TRIGG
OF X-INPUT
BU2
Ampl
Line
freq
POWER ON
SK6
Line
Transf
+
Rect
EXT DC Supp
BU 5

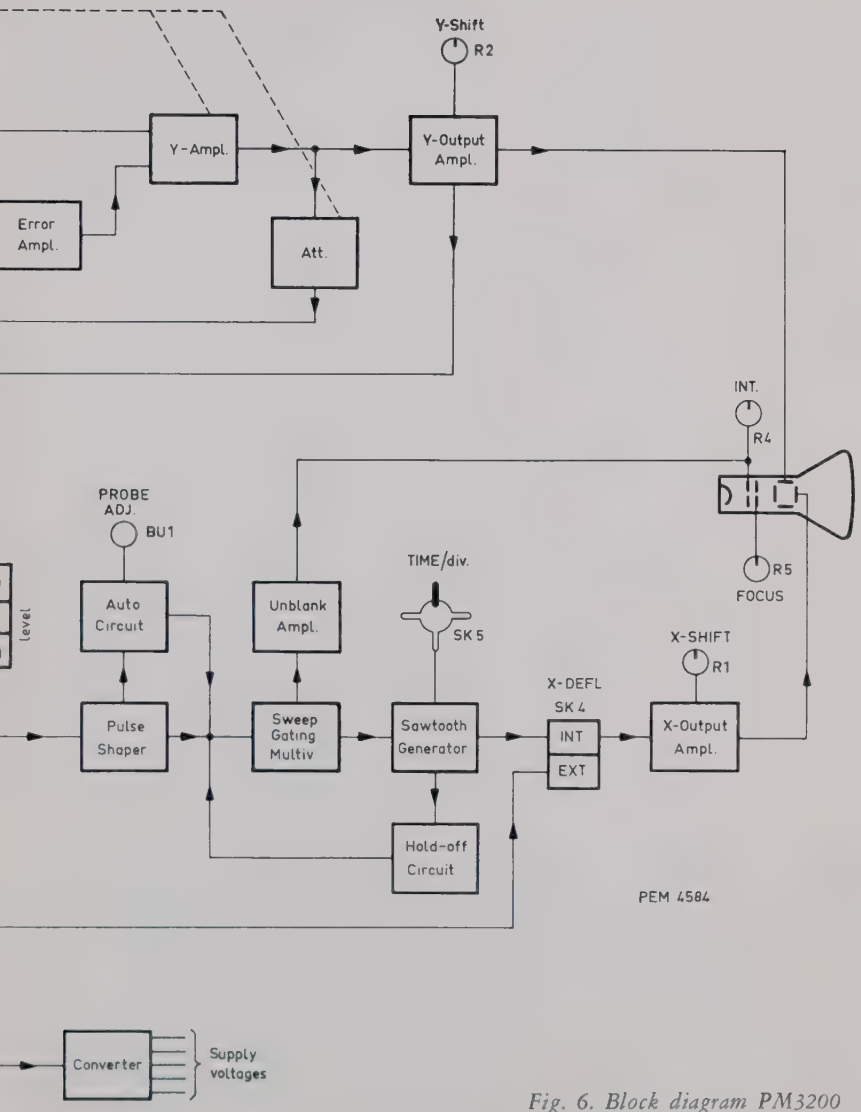


Fig. 6. Block diagram PM3200

In combination with the input attenuator the following pattern of deflection coefficients is obtained:

Gain factors:	*50x*	*20x*	*10x*	*5x*	*2x*
1x	2 mV/div	5 mV/div	10 mV/div	20 mV/div	50 mV/div
Input attenuation			0.1 V/div	0.2 V/div	0.5 V/div
100x			1 V/div	2 V/div	5 V/div
1000x			10 V/div	20 V/div	50 V/div

4. Drift compensation

The Y-amplifier described above receives the input signal in the series fed-back stage via B26′ (input I), and the drift compensation voltage via B26″ (input II).
All drift voltages are related to input I; it is assumed that they originate from a voltage source Ud (see Fig. 7).

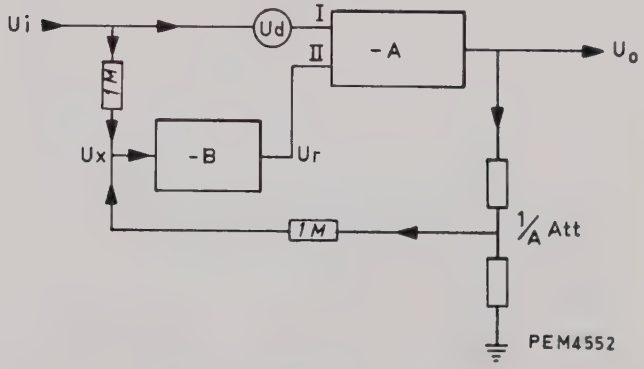


Fig. 7. Block diagram drift compensation circuit

Assume that the Y-amplifier has a gain of -A times and that the drift compensation amplifier has a gain of -B times. The output voltage Uo is then derived by A. In the circuit diagram this 1/A voltage divider consists of R84-R92 with switchable resistors R91, R41, R42, R43.
The output signal from the 1/A voltage divider and the input signal Ui are applied to an adder circuit formed by two 1-MΩ resistors.

Input voltage Ux of the drift compensation amplifier then becomes $Ux = \frac{1}{2}$ (Ui + Uo/A). After this voltage has been amplified, control voltage Ur is obtained: $Ur = \frac{1}{2}B$ (Ui + Uo/A). The difference between input I and input II is amplified -A times, so that Uo = -A (Ui + Ud) – Ur. From this it follows that

$$Uo = -A \left(Ui + \frac{Ud}{1 + \frac{1}{2}B}\right)$$

The effect of Ud, the drift voltage, is thus reduced by approx. $\frac{1}{2}B$. In this instrument B is approx. 50 so that the drift voltage is reduced approx. 25 times.

By means of R77 the d.c. balance is adjusted; R81 serves for adjusting the grid current compensation.

5. Output amplifier

The signal is now applied to the base of TS41 which forms part of the push-pull output amplifier. By varying the series feedback with R113 the overall gain can be adjusted. The frequency dependent element R110-C62 corrects the gain factor at high frequencies. The Y-shift voltage, derived from potentiometer R2, is applied to TS38.

The last stage consists of two "single-ended push-pull" sections, viz. TS34, 36, 37, 39 and TS42, 43, 44, 46 with shunt feed-back via R103, R108 and R122, R123 respectively.

Via voltage divider R128 and R129 and emitter follower TS47 a signal is taken off for internal triggering of the time base generator.

C. X-DEFLECTION

1. Introduction

X-deflection is effected, dependent on the position of SK4 "X-DEFL.", by a signal applied via input socket BU2 and a preamplifier, or by a sawtooth voltage generated in the instrument.

In the latter case the sawtooth generator may be triggered by a signal which is derived from the Y-signal ("INT"), an external signal applied via BU2 ("EXT") or the mains voltage ("LINE"), dependent on the position of selector switch SK3.

The position of SK2 determines whether triggering takes place on a positive or negative going signal ("+" of "–").

A level circuit permits of triggering on a level which corresponds to the

mean value ("MEAN") or the peak value ("TOP") of the trigger signal or e.g. on the envelope of an LF modulated HF signal ("HF reject"). Selection is effected with switch SK1.

The trigger signal controls a bistable multivibrator, the pulse shaper, which supplies a signal with constant rise time and amplitude to the sweep-gating multivibrator. The sweep-gating multivibrator also receives signals from the automatic circuit and the hold-off circuit. If the sum of these signals is sufficiently negative, the sweep-gating multivibrator will be set, thus permitting the sawtooth generator to effect one cycle. The output voltage of the sawtooth generator increases linearly in time, and its speed is determined by the position of SK5 ("Time/div").

At a certain value of the output voltage the sweep-gating multivibrator is reset so that his voltage is restored to its quiescent level. During the time required for this, the sweep-gating multivibrator is blocked in its quiescent position by the hold-off circuit. After this period the multivibrator is set again by the next trigger pulse so that the sawtooth generator can again effect one cycle. **The circuit is now triggered.** However, if no more trigger pulses arrive within approx. 0.5 sec., the automatic circuit becomes operative. This circuit changes the input level of the multivibrator so that the latter changes over to the set condition. This results in a sawtooth cycle at the end of which the multivibrator is reset, etc. This process is repeated as long as the automatic circuit maintains the above-mentioned level. **The circuit is then free-running.**

During the presence of the trigger pulses a squarewave voltage is present in part of the automatic circuit, which is also used as a signal source for adjusting the measuring probe. Triggering should then be effected via the external trigger input (EXT) or with the mains frequency (LINE). The CRT should only be unblanked during the forward scan of the sawtooth. This process can be controlled direct from the sweep-gating multivibrator; the control voltage is applied to the Wehnelt-cylinder of the CRT via the unblanking amplifier.

2. Sawtooth generator

A linearly increasing voltage is obtained, amongst others, by charging a capacitor via a constant current source: in this instrument the capacitor is represented by one of the capacitors C231, C232, C234, C235 and/or C236 which can be switched over with SK5 (TIME/div) and the constant current source is TS218. The rate of the voltage increase, which also determines the sweep time, is inversely proportional to the capacitance

of the selected capacitor and directly proportional to the current through TS218. This current is determined by the voltage on the base of TS218, the value of which can be adjusted by means of preset potentiometers (settings given in squares in the table below). Moreover, the current is determined by the value of the emitter resistors of TS218, viz. R274... R283 which are also switched over with switch SK5 (TIME/div). The time base speed thus selected can be read in the table given below.

Resistors	*Capacitors*	*(Capacitors C236/C237 are continually switched in).*			
		C229	*C231*	*C232*	*C234//C235*
(R280+R282)		0.5 s/div	5 ms/div		
(R280+R282) // (R283+R274)		0.2 s/div	2 ms/div		
(R280+R282) // (R283+R276)		0.1 s/div	1 ms/div		
(R280+R282) // (R283+R277)		50 ms/div	0.5 ms/div R266	50µs/div	5 µs/div 0.5 µs/div
(R280+R282) // (R283+R278)		20 ms/div	0.2 ms/div	20 µs/div	2 µs/div 0.2 µs/div C237
(R280+R282) // (R283+R279)		10 ms/div R271			
(R280+R282) // R283+R281)			0.1 ms/div	10 µs/div	1 µs/div
(R280+R282) // R283					0.1 µs/div

After reaching a certain voltage the capacitors are discharged by transistor TS213 which is driven into conduction by the sweep-gating multivibrator TS211, TS212.

The sawtooth starts when the sweep-gating multivibrator is in a position in which TS211 is cut off and TS212 is turned on (TS213 is now off). In the following this position will be indicated with position "1".

The other position in which TS211 is on, TS212 is off and TS213 is on will be called position "0".

The sawtooth voltage is taken off by a cascade circuit consisting of emitter followers TS219 and TS221. This voltage is applied both to the hold-off circuit and to the X amplifier, via R294, R296.

The sweep-gating multivibrator, whose input level can be adjusted with R295, may be controlled by:

a. trigger pulses derived from pulse shaper TS206, TS207 via differentiating circuit C221, R249, GR206.
b. hold-off signals.
c. a d.c. level derived from the automatic circuit.

A hold-off signal will set the sweep-gating multivibrator to position "0". After this signal, position "0" is maintained until the next trigger pulse arrives, unless the automatic signal is present; in that case position "1" is assumed immediately after the hold-off signal.

3. Hold-off circuit

Due to the effect of diode GR208, capacitor C239 (and if applicable, shunt capacitor C228 or C232 or C233, C234, C235) cannot follow the decay of the sawtooth voltage.

The capacitor voltage will then decrease with an RC time which is sufficiently great to allow the sawtooth voltage to reach its zero level and to ensure the decay of switching phenomena.

Note: If no use is made of the sawtooth generator, viz. with X-deflection switch SK4 in position 2 ("EXT"), a positive voltage is applied via R 293 so that position "0" is retained.

4. Automatic circuit

Transistors TS214 and TS216 form a monostable multivibrator which responds to the negative-going edges of the collector signal of TS206 which have been differentiated by C222 and R261. Thus, a squarewave voltage is obtained which is rectified by emitter follower TS217 and capacitor C226. The output voltage is applied to the sweep-gating multivibrator via R257.

If there are no trigger pulses, the voltage across the capacitor will decrease so that the sawtooth generator starts to free-run after approx. 0.5 sec. This is also the case of the interval between the trigger pulses is more than approx. 0.5 sec.

Part of the collector voltage of TS214 is available at BU1 for adjusting the measuring probe.

5. Trigger amplifier and pulse shaper

The sweep-gating multivibrator and the automatic circuit are controlled

via a differentiating circuit by a Schmitt trigger TS206, TS207, operating as a pulse shaper. Fig. 8 shows how the Schmitt trigger changes over when an input signal is applied. (Trigger slope – SK2 in position "–").
From this figure it appears that the input signal should exceed both limits of the hysteresis gap to obtain triggering.

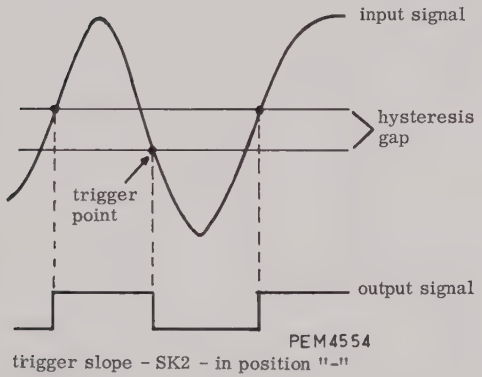


Fig. 8. Working of pulse shaper in the case of triggering (average value)

The relation between the signal level and the location of the hysteresis gap depends on the position of SK1:

a. "MEAN" In this position the average level of the a.c. component of the signal is situated near the hysteresis gap. Triggering then takes place near the zero passages of this signal if the peak-to-peak value of the signal is sufficiently large with respect to the hysteresis gap. In this position of SK1 TS203 and TS204 operate as emitter followers.

b. "TOP" In this position d.c. restorage of the applied a.c. coupled signal takes place, so that triggering is effected as shown in Fig. 9; on the left for negative-going signals, on the right for positive-going signals (trigger slope negative).

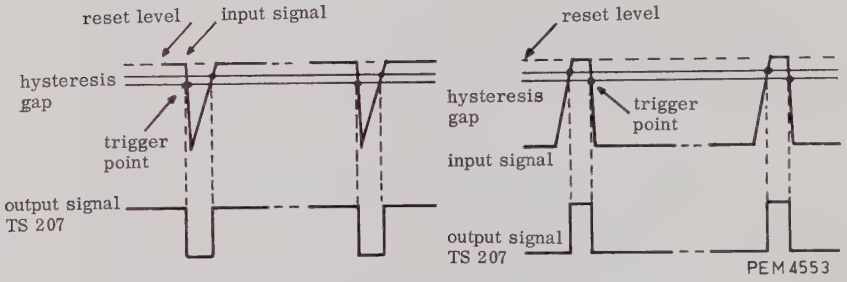


Fig. 9. Working of pulse shaper in the case of triggering (peak value)

If the signal applied is sufficiently large with respect to the hysteresis gap, triggering will take place near the peaks (positive or negative) of the trigger signal in this position of SK1. D.C. restorage is achieved by means of C208 and TS204, which now functions as a diode.

c. "H.F. reject" In this position the trigger signal is detected via a detector circuit consisting of diode GR200, capacitor C207 and resistor R216, before it is applied to the pulse shaper via emitter followers TS203 and TS204. In this way the carrier wave of an amplitude modulated signal can be suppressed. The detection time constant has been adapted so, that the oscilloscope can be used for adjusting the PAL delay line of a colour T.V. receiver operating in accordance with the PAL system.
One of the three trigger signals present on points 3, 4 and 5 of SK3 (INT., EXT., LINE) which are derived from the Y-amplifier, from the external triggering amplifier and from the mains, is passed onto the base of transistor TS202.

This transistor has the same emitter and collector resistance so that the signal at the collector has the same amplitude but is in phase-opposition with respect to the signal at the emitter. Zener diode GR202 restores the d.c. level of the collector signal to that of the emitter signal. One of these signals is selected with SK2 ("+" or "–").

6. Amplifier for external triggering or X-input

A signal on BU2 for triggering or horizontal deflection, is applied to emitter follower TS201 via a continuous attenuator R3. In order to reduce the effect of parasitic capacitances in the continuous attenuator the potentiometer casing is connected to the output of the emitter follower via C203.

7. X-final amplifier

The signal reaches the base of TS222 of the balance final amplifier via R296. The entire amplification can be adjusted by varying the series back-coupling with potentiometer R307. The frequency dependent element i.e. C241 corrects the amplification factor at high frequencies. The X-shift voltage coming from potentiometer R1 is supplied to the base of TS226. The last stage consists of two "single-ended push-pull" sections, namely TS223, TS224 and TS227, TS228 with shunt back-coupling via R298 and R313 respectively.

D. CATHODE-RAY TUBE

1. Crt circuit

Potentiometers R4 and R5 function as brightness and focusing controls respectively. R332 serves for adjusting the level of max. brightness; R329 serves for adjusting to minimum astigmatism.

2. Unblanking circuit

During the forward scan of the time base the Wehnelt cylinder should receive a positive voltage pulse. This pulse is derived from the sweepgating multivibrator and amplified by a single-ended push-pull amplifier consisting of transistors TS208 and TS209. The signal reaches the Wehnelt cylinder via C215 after which d.c. restorage takes place in conjunction with R334 and GR336.

VII Gaining access to the parts

CAUTION

Very high voltages are generated in the instrument, so that when effecting work to the inside of the instrument great care must be taken

A. REMOVING COVER AND CARRYING HANDLE

- Remove the 4 screws with which the cover has been fixed
- The cover can then be slid off the frame
- The handle is secured to the cover with 2 screws
- Remove the nuts from the screws and take off the handle.

B. REMOVING THE KNOBS

- The 2 switch knobs are clamped onto the spindle. Remove the caps and loosen the nut one turn. The knob can now be pulled off the spindle.
- The other knobs are secured on the spindles by means of a clamping spring (pastic). They can be simply pulled off the spindles.

C. REMOVING THE BEZEL AND THE GRATICULE

- The bezel can be removed by slightly compressing the long sides. The contrast-enhancing filter is fitted to the short sides of the bezel by means of two tags.
- The graticule is fitted loose in the recesses of the front plate.

D. REMOVING THE SUPPLY UNIT (unit 4)

- Remove the CRT according to chapter XI point A.
- Remove the 6 fixing screws and unsolder the relevant wires.
- Pull the knobs of the spindles and loosen the cable clamp; the unit can now be slid out of the instrument together with the tube socket.

E. REMOVING THE AMPLIFIER/THE BASE UNIT (Unit 5)

- Unsolder the supply wires.
- Unsolder the wires at the tube socket of the CRT which lead through the partition.
- Unsolder the screened cable leading to the trigger pre-amplifier; remove

as much as possible soldering tin from the hole.
- Unsolder the wires at the input sockets and the "PROBE ADJ" socket.
- Remove the 7 fixing screws.
- Remove the 2 switch knobs and the 2 control knobs.
- Slide the unit backwards and tilt it out of the instrument.

F. REPLACING THE SAFERY FUSE

- Remove the cover (see A) and the plastic case at the rear (2 screws).
- Remove the mains transformer (4 screws).
- Replace the safety fuse at the bottom of the mains transformer.

VIII Adjusting elements and their functions

The correct adjusting sequence and adjusting procedure are given in chapter X.

Adjustment	*Adjusting element*	*Fig.*	*Auxiliary instrument*	*PHILIPS type*	*Chapter X section*
Y-amplifier					
minimum gain	R68	20	Squarewave generator	PM5711	D4
maximum gain	R63	20			D4
gain calibration	R113	20			D5
d.c. balance	R77	20			D1
grid current compensation	R81	20			D2
square-wave response of	C27	25	Squarewave generator	PM5711	D7
attenuators	C32	25			
	C37	25			
input capacitance	C29	25			
attenuators	C34	25			
	C39	25			
bandwidth	C62	27	Sinewave generator	PM5321	D8
X-amplifier and timebase generator					
trace length	R297	20			E1
trigger sensitivity	R220	27	Sinewave generator	PM5160	E3
trigger stability	R295	20	Sinewave generator	PM5321	E4
time coefficients	C237	20	Time marking generator		E6
	R266	20			E6
	R271	20			E6
Power supply					
output voltage	R411	21	d.c. voltmeter	PM2401	B1
CRT					
intensity	R332	21			C
astigmatism	R329	21			C

IX Brief checking procedure

The checks should be carried out at nominal mains voltage.
1 div. = 7½ mm.
Starting positions of the controls:
– Toggle switches to upper position
– Shift controls in centre position
– Focus and intens. controls adjusted for well-defined display
Unless otherwise stated the controls always occupy the same position as in the previous check.

Y-AMPLIFIER

O-AC-DC to 0.
Y-AMPL to 50 mV/div. Centre time-base line with Y-shift. Allow a warming-up of 1 hour.
Y-AMPL to 2 mV/div. The time-base line should remain on the same place within 1 div.
Correction possible with R77.
O-AC-DC to DC.
Time-base line should not shift more than 0.5 div.
Correction possible with R81.

position Y-AMPL.	50 mV/div.	2 mV/div.
Y-input signal: square wave	100 Hz, $t_r \approx$ 100 ns 300 mV_{p-p} ± ½%	100 Hz. $t_r \approx$ 100 ns 12 mV_{p-p} ± ½%.
Check droop	max. 2% corr. with R68.	max. 2% corr. with R63.
Check trace height	6 div. ± 2% corr. with R113.	6 div. ± 5%.

Check all the other attenuator positions: accuracy ± 5%, overshoot 2%.
Input signal: square wave, 2 kHz, $t_r >$ 10 ns.

position Y-AMPL.	50 mV/div.	2 mV/div.
Input signal: sine wave	10 MHz 300 mV_{p-p} ± ½%.	10 MHz 12 mV_{p-p} ± ½%.
Check trace height, at least	4.2 div.	4.2 div.

TRIGGERING

Y-input signal: sine wave, 2kHz for trace height of 1 div. resp. sine wave 10 MHz for trace height of 2 div.
Check that the trace is triggered.

X-AMPLIFIER

O-AC-DC to O. potentiometer X-INPUT clockwise. X-DEFL to EXT.
X-input signal: square wave $2V_{p\text{-}p}$, 2 kHz, $t_r \approx 100$ ns.
Check that the deflection amounts to 7 to 10 div. and can be decreased to 0 by potentiometer X-INPUT;

TIME-BASE GENERATOR

O-AC-DC to AC. LEVEL to TOP. +/– to +.
INT-EXT-LINE to INT. TIME/div. to 0.5 msec/div.
Y-input signal: time markers with a repetition rate of 0.5 ms.
Check that time markers 2... 9 occupy a total width of 7 div. ± 5%.
Check the other TIME/div. settings.
Tolerance ± 5 % in all positions except 0.5-0.2-0.1 sec/div.
and 0.5-0.2-0.1 μsec/div. Here the tolerance is ± 7%.
After this carry out a quick functional check of all controls that are not checked yet.
INT-EXT-LINE to position LINE;
Check the presence of a square wave on socket PROBE ADJ.

X Checking and adjusting

A. GENERAL

The adjusting elements, their functions and location are given in chapter V and VIII. Tolerances given in this chapter apply to a completely re-adjusted instrument. Therefore they may differ from those specified in chapter II.

B. POWER SUPPLY

1. Control circuit

- Connect a voltmeter between earth and point "A" of Unit 5 (Fig. 27) and adjust the voltage to + 12,6 V (± 0.1 V) by means of potentiometer R411.
- Check the other supply voltages:

Point	*Voltage*
"B"	— 12.8
"C"	+ 90
"D"	+210

- Check the proper working of the control circuit by varying the mains voltage. A variation of 10% should have no effect on the output voltage.

2. Hum and ripple

Check the supply voltages for hum and ripple. The overall peak to peak value should be smaller than 20 mV.

C. PRELIMINARY ADJUSTMENT FOR DISPLAYING A TIME BASE LINE

- Set all toggle switches to the upper position, the shift potentiometers to the mid position, turn the intensity control clockwise and set "V/div" to 50 mV/div.
- Turn R295 until a time base line appears.
- Apply a sinewave voltage (approx. 1 kHz) with a trace height of 6 divisions.
- Set R4 to max. intensity and adjust R332 so that the trace is just "blown up".
- Adjust to normal intensity with R4.
- Adjust for min. astigmatism with R329 (readjusting R5 "FOCUS").

D. Y-AMPLIFIER

1. DC balance

- Allow the instrument to warm up for approx. ½ hour (cabinet not removed).
- Set SK7 to position "50 mV/div" and SK8 to position "0".
- Centre the time base line with R2.
- Set SK7 to position "2 mV/div" and (after removing the cabinet) centre the time base line again with R77.

2. Grid current compensation

- Set SK8 to position "DC"; the time base line should not be shifted when switching from "0" to "DC" or vice versa.
- Adjust R81 so that the trace is not shifted any longer.
- Repeat 1) and 2) until an optimum setting is obtained.

3. Checking for hum, noise and microphony

- Set SK7 to position "2 mV/div" and SK8 to position "0".
- The height of the trace arising due to hum and noise should not exceed 0.2 div.
- When changing over SK5 "TIME/div" the pulses arising due to microphony should not have a trace height exceeding 2 divisions.

4. Gain (intermediate stage)

- Set SK3 to position "INT".
  SK4 to position"INT".
  SK5 to position "5 ms/div"
  SK7 to position "50 mV/div"
  SK8 to position "DC".
- Apply a squarewave voltage of 300 mV_{p-p} at 100 Hz.
- Adjust for proper squarewave response witht R68.
- Set SK7 to position "2 mV/div".
- Reduce the squarewave voltage to 12 mV_{p-p} at 100 Hz.
- Adjust for proper squarewave response with R63.
- Check the squarewave response with SK7 in positions 5-10-20 mV/div.

5. Calibration

- Set the switches as indicated under D4 but SK5 in position "0.2 ms/div".
- Apply a square wave voltage of 300 mV_{p-p} ($\pm$ 1%), 2 kHz.
- Accurately adjust R113 to a trace height of 6 divisions.

6. **Input RC element**
   - For adjusting the input capacitance a standard RC element is required consisting of a fixed 1 MΩ ($^1/_8$ W, 1%) resistor shunted by a variable capacitance e.g. a 3-60 pF trimmer.
     This element is adjusted as follows:
   - Set the switches as indicated under D4, however, SK5 in position "0.2 ms/div".
   - Apply a squarewave voltage of 600 mV_{p-p}, 2 kHz via the input RC element and adjust the trimmer for proper squarewave response.

7. **Squarewave response and input capacitance**
   - Set SK7 to position "0.2 V/div".
   - Apply a squarewave voltage of 1.2 V_{p-p} (± 1%), 2 kHz.
   - Adjust C37 for proper squarewave response and check the Y-deflection over 6 divisions.
   - Connect the adjusted input RC standard element, set SK7 to "0.1 V/div" and adjust for proper squarewave response with C39.
   - Remove the input RC standard element.
   - Set SK7 to position "2 V/div".
   - Apply a squarewave voltage of 12 V_{p-p} (± 1%) 2 kHz.
   - Adjust for proper squarewave response with C32 and check the Y deflection.
   - Adjust for proper squarewave response with connected input RC standard element and SK7 at "1V/div" by means of C34.
   - Similarily adjust C27 and C29 with SK7 in position "20 V/div" and "10 V/div" respectively.

8. **Bandwidth**
   - Set SK1 to position "MEAN".
     SK2 to position "+".
     SK3 to position "INT".
     SK4 to position "INT".
     SK5 to position "1 µs/div".
     SK7 to position "2 mV/div".
     SK8 to position "DC".
   - Apply a sinewave signal of 12 mV_{p-p}, 10 MHz.
   - The trace height should not be less than 4.2 div.
   - If necessary increase C62 (e.g. after replacing the CRT or transistors of the Y-output amplifier).
   - Check the overshoot with a squarewave voltage of 12 mV_{p-p}, 1 MHz rise time $\leq$ 10 ns.

9. **Shift control range**
   - Set SK7 to position "50 mV/div" and apply a sinewave voltage of 1.2 V_{p-p}, 1 MHz.
   - It should be possible to display the peaks of the signals undistorted within the measuring lattice by means of R2.

E. X-AMPLIFIER AND TIME BASE

1. **Trace width**
   - Set al tolggle switches to the upper position.
   - Set SK5 to position "10 μs/div" and SK8 to position "0".
   - Adjust the trace length to 10.5 div. with R307.

2. **Trigger sensitivity**
   - Apply a sinewave voltage (1 kHz) to the Y amplifier.
   - Set all toggle switches to the upper position.
   - At a trace height of 0.9 div. it should still be possible to obtain a triggered trace; if necessary, adapt with R220 (over switch SK1).

3. **Stability**
   - Apply a sinewave voltage of 10 MHz, trace height 2 divisions, SK5 in position 0.1 μs/div.
   - Adjust R295 until a triggered picture is obtained.
   - Check the correct adjustment by setting SK8 in position "0"; after approx. 0.5 sec. the time base should start to free-run.

4. **Triggering with mains frequency + PROBE ADJ. signal**
   - Set all toggle switches to the upper position.
   - Apply a signal of mains frequency to the Y-amplifier. The signal should have such an amplitude that a non-triggered trace is obtained.
   - Set SK3 to position "LINE".
   - Check whether a triggered trace is obtained.
   - Check that a squarewave voltage is available on BU1 with an amplitude of approx. 0.25 V_{p-p}, superimposed on + 1 V dc.

5. **Sweep time**
   - Apply a time marking signal witht a repetition time of 0.5 ms; Trace height max. 3 divisions.
   - Set SK5 to position "0.5 ms/div".
   - Check the triggering with SK1 in position "TOP" (SK2 in position "+" for positive going signals, and in "–" for negative going signals).

- With R266 adjust the sweep time so that the 2nd... 9th pulse accurately coincide with the lattice gradation.
- Check the sweep time in positions "5 ms/div... 1 µs/div".
- After this, adjust the sweep times 0.1 µs/div, 0.2 µs/div and 0.5 µs/div with C237.
- Set SK5 to position 10 ms/div and apply time markers with a repetition time of 10 ms.
- Adjust R271 so that the 2nd... 9th pulse accurately coincide with the gradation.
- Check the sweep times at the other positions of SK5.

F. EXTERNAL TRIGGERING

- Set SK1 to position "MEAN".
  SK2 to position "+".
  SK3 to position "EXT".
  SK4 to position "INT".
- Apply a sinewave voltage of 1 kHz to the Y-input.
- Apply a sinewave of the same frequency to BU2; the signals should have an amplitude of 1 $V_{p\text{-}p}$. Turn R3 clockwise.
- Check whether a triggered trace is obtained.
- Check this at the same setting and at a frequency of 10 MHz and an amplitude of 2 $V_{p\text{-}p}$.

G. X-DEFLECTION

- Set SK4 position "EXT".
- Apply a squarewave voltage of 3 $V_{p\text{-}p}$. 2 kHz to BU2.
- The trace width should be more than 10 div with R3 fully clockwise.

XI Replacing parts

During the replacement of parts, the instrument should be switched off.

A. REPLACING THE CRT

- Remove the cover
- Remove clamping screw "A" (Fig. 21) and screw "B".
- Remove the bezel and the graticule.
- Slide the CRT slightly backwards and detach the tube socket. The CRT can now be removed from the mu-metal screen.

B. REPLACING THE SWITCH TURRET OF THE TIME BASE (Unit 2) AND THE ATTENUATOR (Unit 3)

- Detach the stop springs.
- Mark the position of the switch knob with respect to the switch turret.
- Loosen the Allen bolt with a 1/16" Allen key.
- Remove the spindle and lift the switch turret from the printed circuit board.
- When fitting a new switch turret the contact pressure of the switch springs should be 20 to 60 g. The contact tracks should be lightly lubricated with Synthesin M (Kluber).

C. REPLACING THE SLIDE SWITCHES

- Remove Unit 5 in accordance with Chapter VII point E.
- Remove the U-shaped coupling springs and remove the coupling rods.
- The toggle lever can now be removed by pressing together the metal casing and sliding it out of the front plate.
- The slide switch can be removed after unsoldering (suction soldering iron) the contacts at the wiring side of the printed circuit board.
- After refitting, the toggle levers should be placed in the upper position (extreme right) so that the cursor of the switch protrudes as far as possible into the switch casing.
- Place the coupling spring in its original position and slide the cursor slightly outwards so that the metal band around the cursor completely protrudes from the housing (also see the mark on the narrow side of the cursor).

D. REPLACING THE TRANSISTORS OF THE VOLTAGE CONVERTER

- Remove the bottom plate (8 screws).
- The 4 transistors can now be unsoldered and pulled out of the heat sinks.

E. REPLACING TRANSISTOR BCY 87

As regards the difficulty of delivering this double transistor, alternative solutions have been found for instruments with type no. /03C,/04 and following.

1. Use of two transistors BC109C thermally coupled with a bracket and a plastic cap.
   As regards the practical execution of the BCY87 (see Fig. 10), the connecting wires (insulated) of the two BC109C are bent in the position shown in Fig. 10.
   When replacing this combination during service operations it can be changed over to type BCY87 as it is, if in stock.
2. The tracks have been modified in the instruments distinguished by the imprint 2xBC109C on the printed wiring board of the Y-amplifier and thus makes it possible to mount the combination 2xBC109C without bending the connecting wires as shown in Fig. 10.
   For replacement, a unit of two thermally coupled transistors (without plastic cap) can be ordered from Central Service under no. 4822 130 40662.

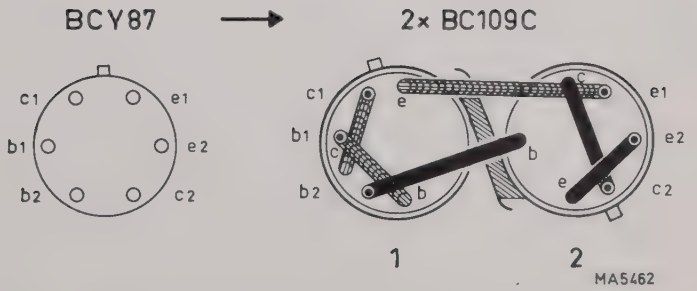


Fig. 10. Lay-out of transistor mounting (BCY 87 and BC 109C)

XII Fault finding

A. VOLTAGES AND VOLTAGE WAVEFORMS

The voltages and voltage waveforms indicated in the circuit diagram and the wiring diagrams have been measured under the following conditions:
- a squarewave signal (½ T) of 1 kHz, 250 mV_{p-p} applied to BU4
- switch SK5 in position "5 ms/div"
- switch SK7 in position "50 mV/div"
- all toggle switches in the upper position.

The direct voltages have been measured with a PHILIPS d.c. voltmeter PM 2401. These values may slightly differ per instrument and should therefore be considered as target values.

B. NOTES

1. Various sub-circuits can be simply disconnected, as in the printed circuits interruptions have been made which are interconnected with soldering tin. In the circuit diagram these interruptions are indicated by means of encircled capacitor symbols.
2. For carrying out measurements to the unblanking circuit, capacitor C215 (–1500 V!) should first be discharged by means of a resistor of some tens of kΩ, so that the test pins can be applied in the discharged condition.
3. When the instrument is to be forwarded to a PHILIPS service workshop the following points should be observed:
   - Carefully pack the instrument in the original packing or, if this is no longer available, in a wooden box.
   - Give a complete description of the fault symptom(s).
   - Attach a label to the instrument bearing your name and adress.
   - Forward the instrument direct to the PHILIPS address provided by the local organisation.

XIII *Information concerning accessories*

A. ADAPTOR PM 9051

This is an adapter to make a BNC socket suitable for the connection of two 4 mm plugs.

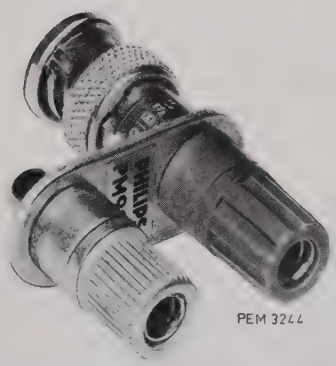


Fig. 11. Adapter PM 9051

B. ATTENUATOR PROBE SETS PM 9326 AND PM 9327

These passive probe sets for a.o. the PM 3200 are equal but for the length for the probe cable, which is 1.15 m (3.8 ft) for the PM 9326 and 2 m (6.5 ft) for the PM 9327.

The sets consist of:

1 probe cable	Fig. 12a
1 earthing flex 15 cm (6″)	Fig. 12b
1 earthing flex 30 cm (1′)	Fig. 12c
1 measuring probe 1 : 1 (black)	Fig. 12d
1 measuring pin	Fig. 12e
1 measuring hook	Fig. 12f
1 attenuator probe 1 : 10 (grey)	Fig. 12g
1 measuring clip	Fig. 12h
1 box	Fig. 12i

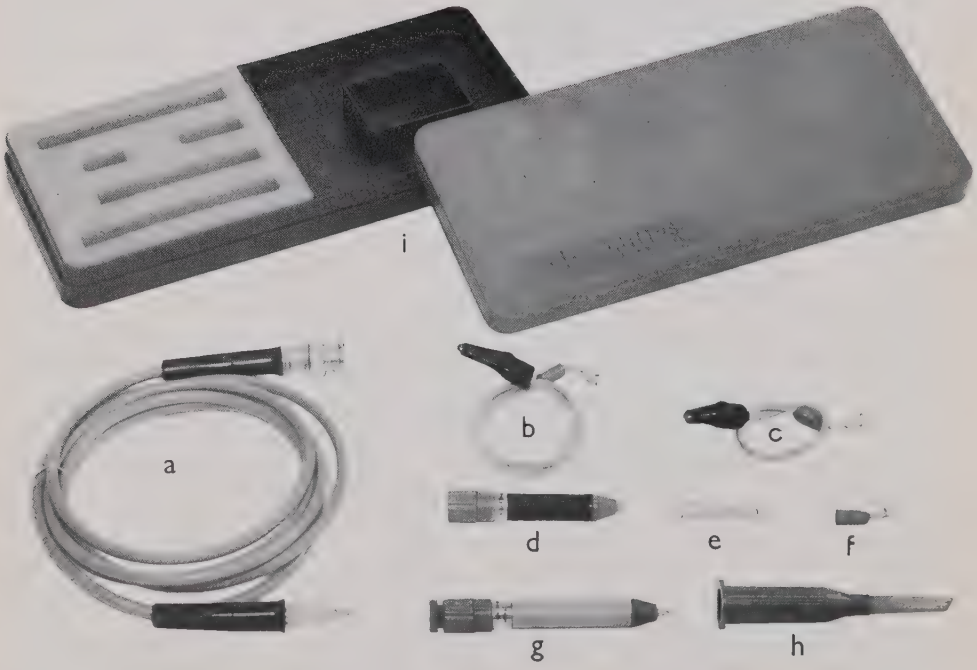


Fig. 12. Probe set

Technical data

Attenuation : 1 : 10 ± 3%
Input impedance : 10 MΩ//8pF
Max. permissible : 1,000 V_{p-p} input voltage.

Maximum d.c. component 500V with the blocking capacitor included into the circuit.

Note: – The adjustment of the 10 : 1 attenuator probe is described in chapter V, B2.
– The measuring probe and the earthing wire can be simply pulled from the cable. The measuring clip, 4-mm plug and the measuring hook are screwed onto the measuring probe.

C. BATTERY CASE PM 9390; PM 9391

INTRODUCTION

Battery pack PM 9391 is designed to make portable oscilloscope PM 3200 independent on the mains voltage.
The PM 9391 contains 20 Ni-Cd accumulator cells, supplying a voltage of 24 Volts.
For replacement purposes an empty battery case in available under type number PM 9390.

1. Technical date PM 9391

Operation time : 4½ hours (continuous operation)
Charging time : 14 hours
Batteries : 20 DEAC RS 3,5 types
Dimensions : 17.5 cm (6.8") x 21 cm (8.3") x 7.3 cm (2.9")
Weight : 4½ kg (10 lbs)

2. Installation (see Fig. 13)

– Remove the plastic case (2 screws "A").
– Remove interconnection plug "B" and insert plug "C" into the socket.
– Secure the battery case with three screws "D".

3. Operation (see Fig. 16)

a. Set switch SK10 to position "OFF".
The battery supply is now switched off.
Mains supply is possible (mains switch in the upper position).
During mains supply the batteries remain charged via the mains rectifier (trickle charging).

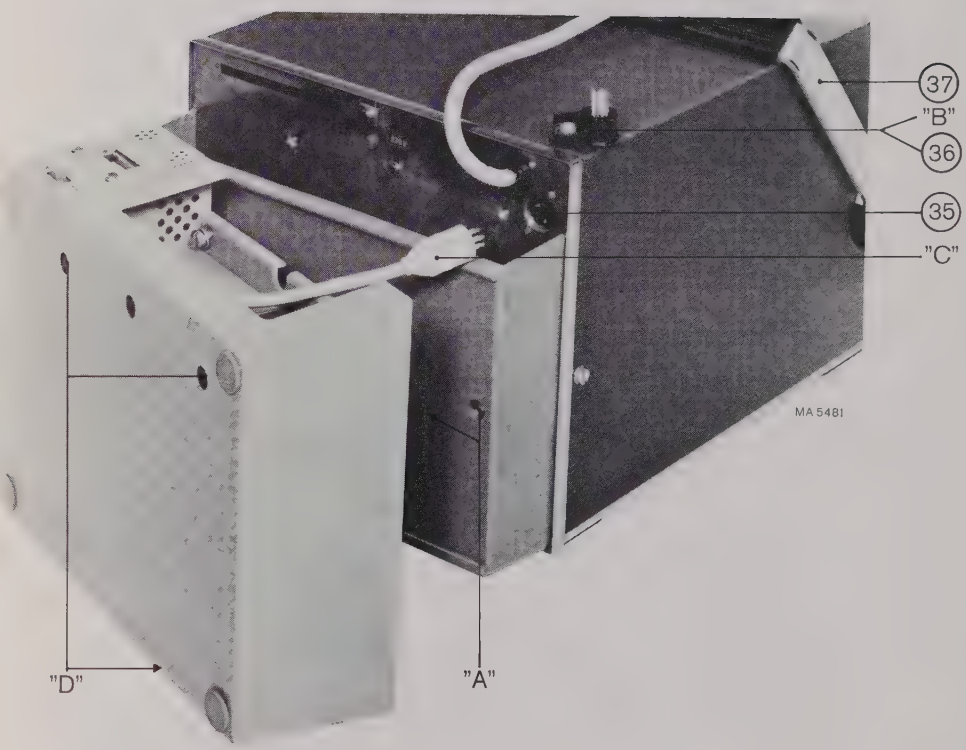


Fig. 13. Installation of battery case + rear view with indication of parts

b. Set switch SK10 to position "BATT. ON".

The mains supply is now inoperative.
The instrument then operates on the battery supply.
Meter M1 indicates after a few minutes the actual charging condition of the cells:
GREEN – full deflection – the batteries are fully charged.
RED – half deflection – charging is desirable.
BLACK – less than half deflection – charging is necessary.

c. Set switch SK10 to position "CHARGE".

The instrument is out of operation.
The cells are charged by the mains rectifier.
Lamps "LA" should light up, meter M1 is inoperative.
As stabilising circuits have been employed, the charging current is practically constant. Therefore it is possible to temporarily interrupt the charging process. However, it will be noticed that meter M1 will show full-scale deflection immediately after changing over from "CHARGE" to "BATT.ON". Only after a few minutes the meter will indicate the actual charging condition.
When the cells are accidentally overcharged, this will not affect their service life (provided this does not take place regularly).

Note: – When it is expected that the instrument should operate on the mains supply for a prolonged period, it is advisable to fully charge the batteries. This will prolong their service life.
– When the battery case is removed, switch SK10 should be set to position "OFF" to prevent short-circuiting via the plug pins.

4. Circuit description (Fig. 14)

The circuit will be described on the basis of the positions of switch CHARGE-OFF-BATT.-ON (SK10).

CHARGE: Two groups of 10 batteries in series, are charged in parallel circuit. The charging current is provided by the mains rectifier of the PM 3200 when its mains switch is closed.
The charging current flows from point 5 of BU7 via current limiting resistor R5 to both groups of batteries and the loop is closed at point 2 of BU7.
R1 and R2 are PTC resistors which, together with LA1 and LA2, keep the charging current practically constant during the charging process. Lamps LA1 and LA2 moreover indicate the

charging condition. Diodes GR1 and GR2 serve to protect the batteries from reverse currents and mutual discharge.

OFF: The PM 3200 operates on the mains supply, keeping the batteries trickle charged via R3.
The circuit is the same as in the former position with exception of resistor R3 and the connection between points 5 and 6 of BU7 that is effected to supply the PM 3200.
Due to the minute charging current, lamps LA1 and LA2 will not light up.

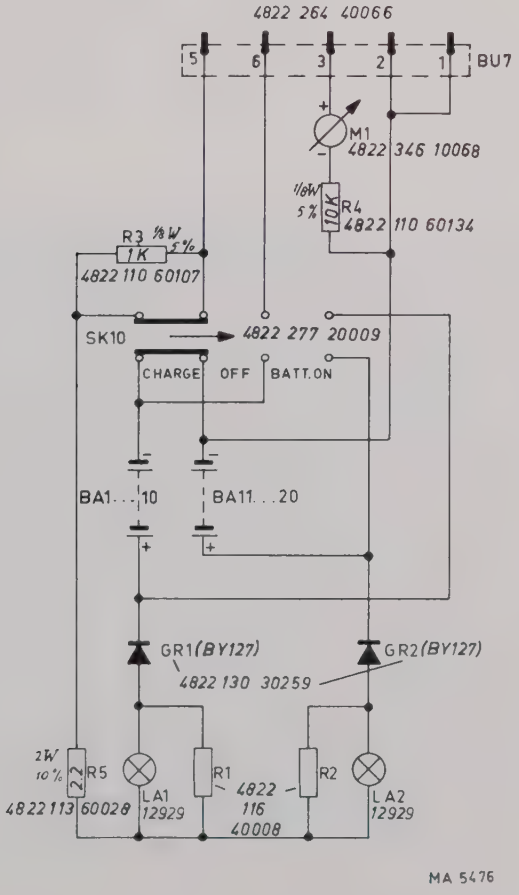


Fig. 14. Circuit diagram of PM 9390 (battery case)

BATT.ON: In this position the battery pack supplies the PM 3200, independent on the position of the mains switch of the latter. The 2 groups of batteries are connected in series.
Meter M1 indicates the actual charge condition of the batteries.

Fig. 15. View of battery case

5. Mounting prescription for PM 9390

- Remove the 5 screws S (Fig. 15).
- Remove the lid and the upper rubber mat.
- Fit the 20 batteries in the case in the way shown in Fig. 16.
  (First fit the outer ones and afterwards fill up the room in the centre.)
- Interconnect the batteries exactly as indicated in Fig. 16.
  Connecting material as wires and grommets are supplied with the PM 9390.
- Fit the rubber mat over the batteries.
- Replace the lid and secure it with the 5 screws S.

Note: To avoid short circuiting of the batteries during the mounting, leave the rubber cover over the plug of the battery pack.
Only use batteries with a diameter of 33 mm, an overall height of 61 mm and the connecting terminals (soldering tags) at the upper side. The voltage of a fully charged battery should amount to 1.2 volts.

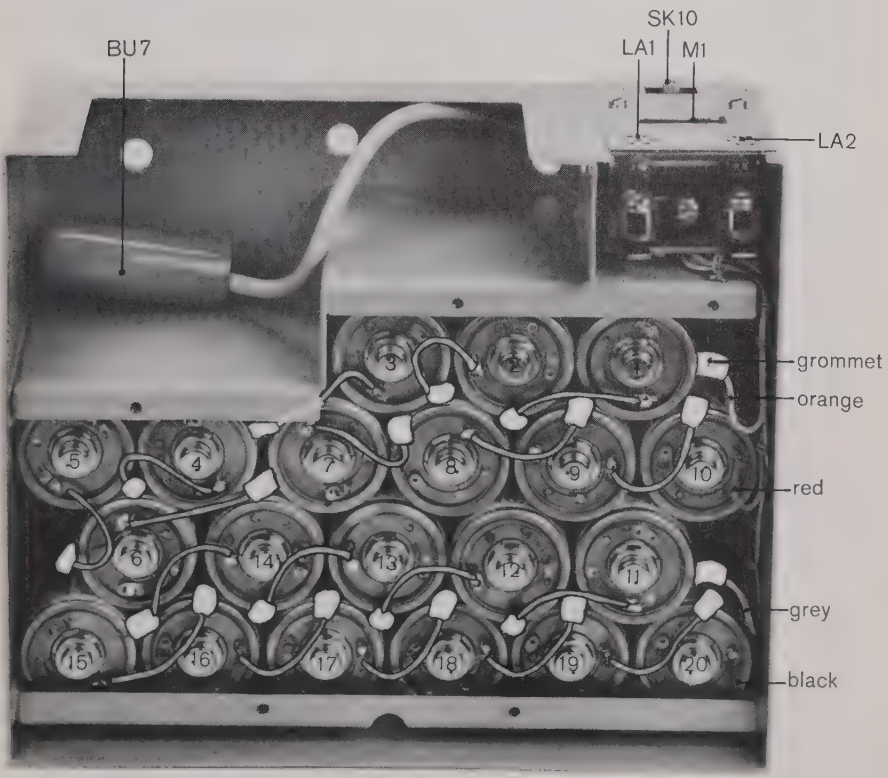


Fig. 16. View of opened battery case

D. ADAPTER PM 9392 FOR EXTERNAL 24 V D.C. SUPPLY

Introduction

This adapter has been designed to facilitate switching over from mains supply to battery supply and vice versa.

Installation

- Remove interconnection plug BU6 (item 36, Fig. 13) and insert plug BU8 of adapter in socket BU5 (item 35, Fig. 13)
- Connect BU9 (–) and BU10 (+) to CORRECT points of external voltage source.

Operation (Fig. 17) and circuit-diagram description (Fig. 18)

a. Switch SK11 in position OFF.
d.c. voltage supply switched off. Mains voltage possible (mains switch in position POWER ON).
In this position SK11 has the same function as interconnection plug BU6.

b. Switch SK11 in position 24 V⎓.
The mains voltage is out of operation. The instrument works on the external supply source. Diode GR1 acts as protection for oscilloscope if supply is not connected with correct polarity.

External voltage source

This voltage must be 22 to 30 V and be able to supply a current of approx. 0.6 A.

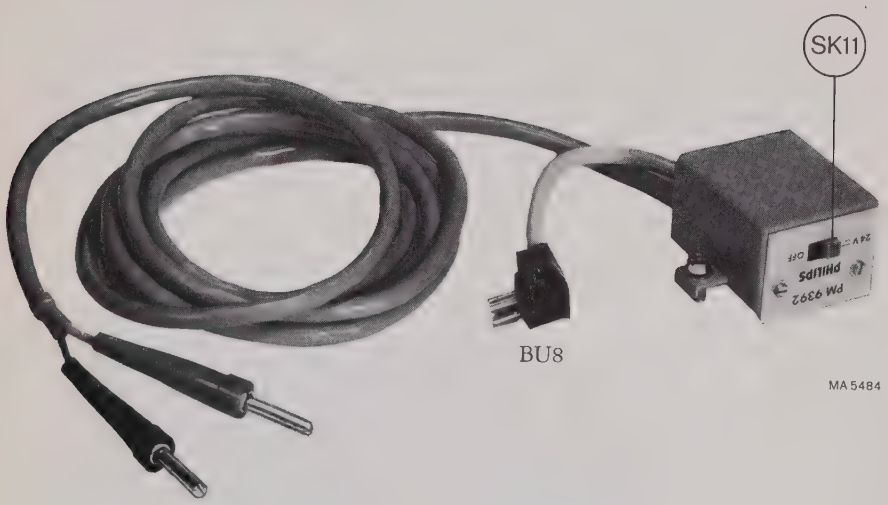


Fig. 17. View of adapter PM 9392.

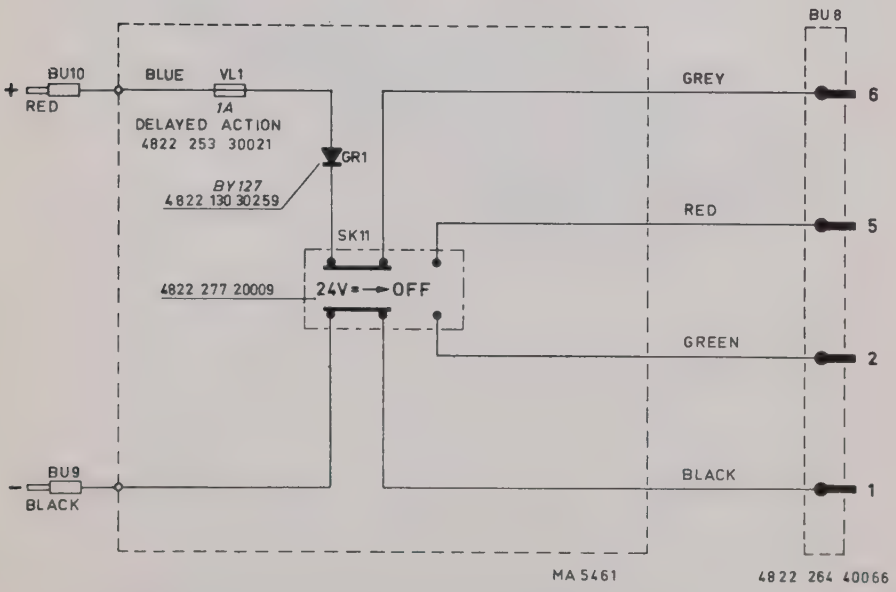


Fig. 18. Circuit diagram of adapter PM 9392

E. CARRYING CASE PM 9393

This is a leather carrying case large enough for a PM 3200 with battery case and accessories, such as probe set and measuring cables.
The case is so constructed that the PM 3200 can be used with mains supply, battery supply or an external voltage supply without removing it from the case.

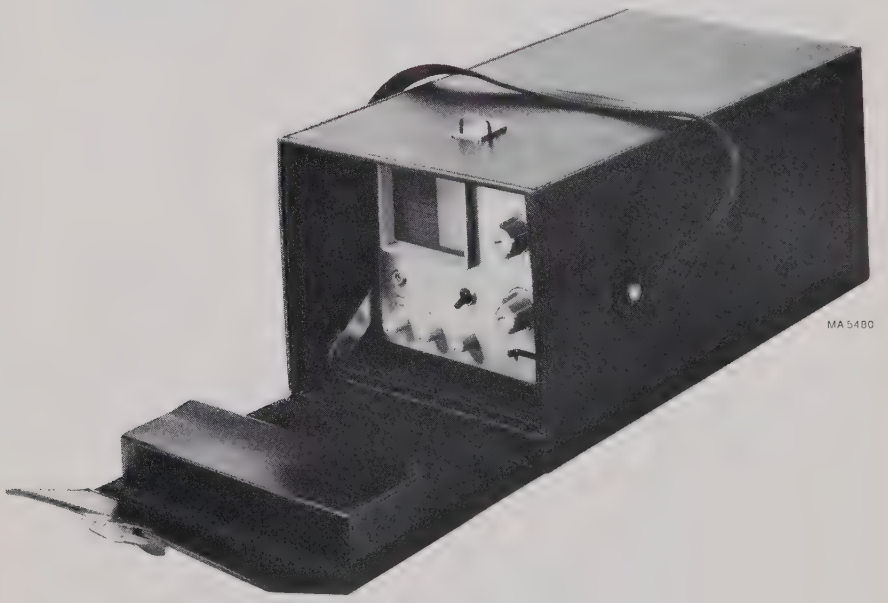


Fig. 19. Carrying case PM 9393

XIV List of parts

A. MECHANICAL

Item	*Fig.*	*Qty*	*Ordering number*	*Description*
1	22	1	4822 455 80052	Text plate
2	21	4	4822 462 40201	Foot
3	21	1	4822 462 70553	Mains cord container
4	22	1	4822 450 10028	Graticule
5	22	1	4822 480 30072	Contrast plate
6	22	1	4822 459 40199	Window
7	22	1	4822	AMP contact pin (BU1)
8	22	1	4822 492 60799	Spring for BU1
9	22	1	4822 267 30045	Terminal 4 mm (BU2)
10	22	1	4822 535 20023	Earthing terminal (BU3)
11	22	1	4822 506 40016	Nut for BU3
12	20	1	4822 267 10004	Connector BNC (BU4)
13	22	1	4822 277 10021	Mains switch (SK6)
14	21	1	4822 277 20014	Mains selector switch (SK9)
15	21	1	4822 321 10073	Mains flex
16	22	2	4822 413 40112	Knob 23Ø (SK5, SK7)
17	22	2	4822 413 70037	Cover (SK5, SK7)
18	22	2	4822 413 30346	Knob 14Ø (R1...R5)
19	22	5	4822 413 70038	Cover (R1...R5)
20	22	5	4822 411 50169	Knob for SK1-2-3-4-8
21	20	1	4822 277 30408	Slide switch (SK1)
22	20	1	4822 277 30409	Slide switch (SK2)
23	20	2	4822 277 30411	Slide switch (SK3, SK8)
24	20	1	4822 277 30412	Slide switch (SK4)
25	20	1	4822 105 30046	Switch (time base: U2)
26	20	1	4822 105 30047	Switch (attenuator; U3)
27	21	1	4822 145 40088	Mains transformer (T401)
28	21	1	4822 142 60115	Oscillator coil (L407)
29	21	1	4822 216 50133	Printed circuit (Unit 4)
30	20	1	4822 216 50134	Printed circuit (Unit 5)
31	20	1	4822 255 70004	Valve holder (B26)
32	22	1	4822 325 80058	Insulating ring (BU1)
33	22	1	4822 381 10166	Lens
34	21	1	4822 255 70109	Valve holder (CRT)
35	13	1	4822 267 40127	Socket 6 cont (BU5)
36	13	1	4822 264 40066	Plug 6 cont (BU6)
37	13	1	4822 498 40285	Carrying handle
38	20	4	4822 705 15163	Ratchet spring

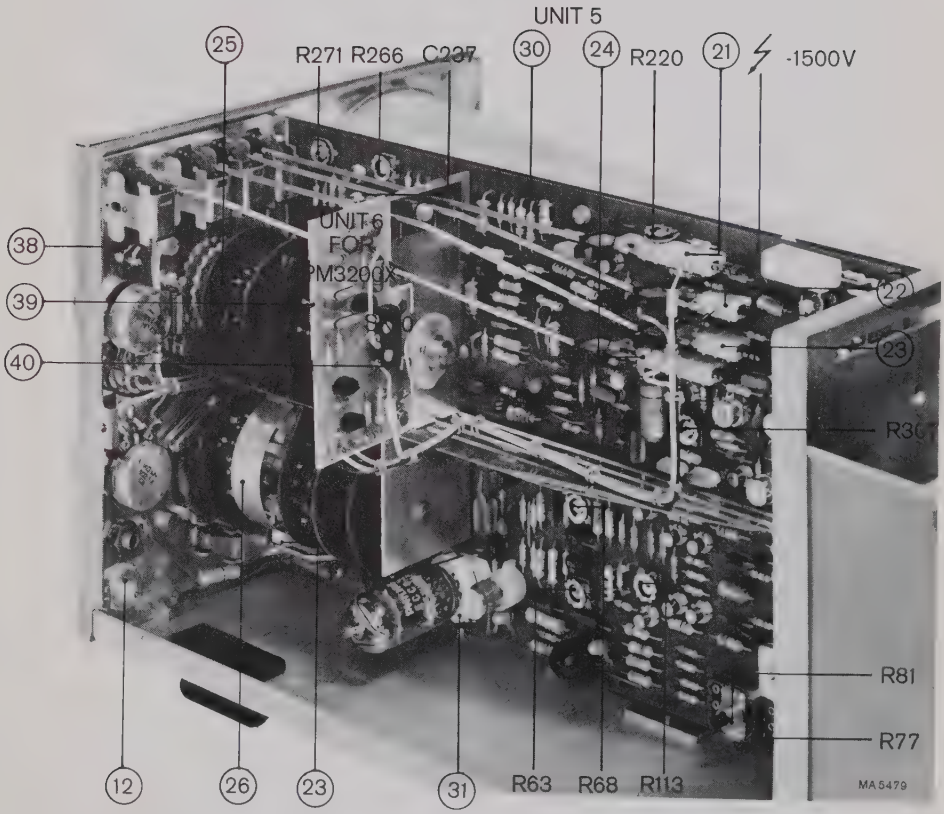


Fig. 20. View of unit 5 with indication of adjusting elements + Unit 6 (PM3200X)

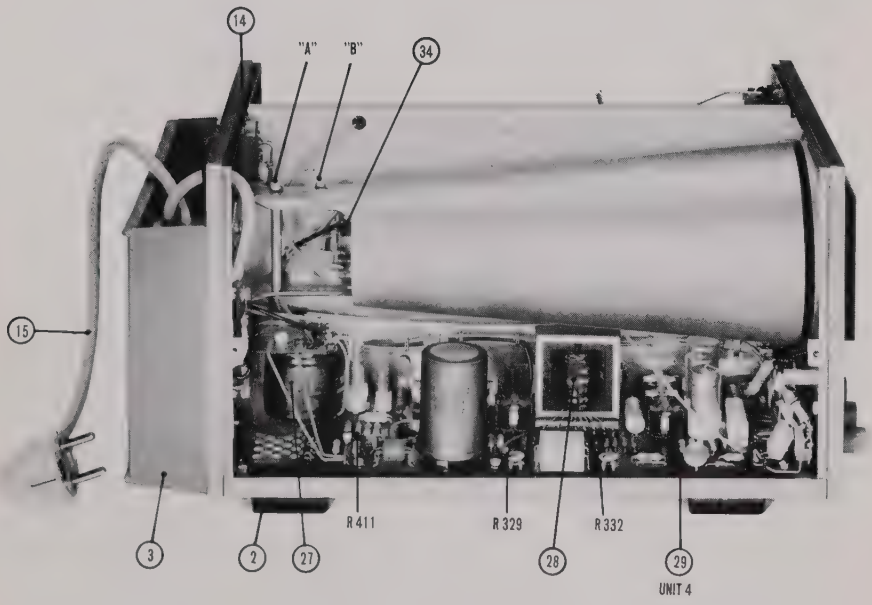


Fig. 21. View of unit 4 with indication of adjusting elements

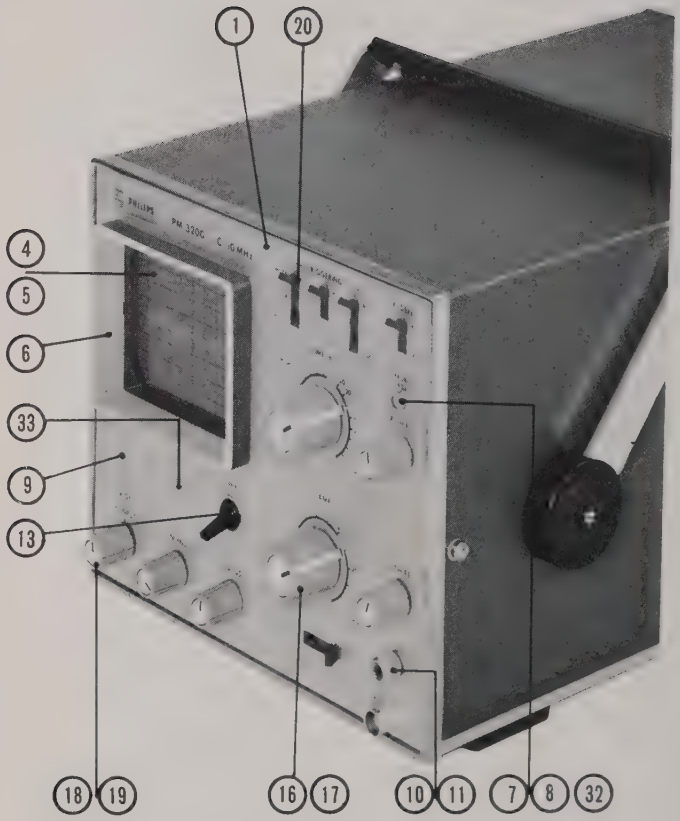


Fig. 22. Front view with indication of parts

B. ELECTRICAL — ELEKTRISCH — ELEKTRISCH — ELECTRIQUE — ELECTRICOS

This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het principeschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs specifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
} 0,125 W 5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 1 W ≦ 2,2 MΩ, 5%
> 2,2 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 0,25 W ≦ 1 MΩ, 5%
> 1 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 2 W 5%

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
} 0,5 W ≦ 5 MΩ, 1%
> 5 ≦ 10 MΩ, 2%
> 10 MΩ, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
} 0,4 – 1,8 W 0,5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 0,5 W ≦ 1,5 MΩ, 5%
> 1,5 MΩ, 10%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
} 5,5 W ≦ 200 Ω, 10%
> 200 Ω, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
} 10 W 5%

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
} 500 V

Polyester capacitor
Polyesterkondensator
Polyesterkondensator
Condensateur au polyester
Condensador polyester
} 400 V

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
} 700 V

Flat-foil polyester capacitor
Miniatur-Polyesterkondensator (flach)
Platte miniatuur polyesterkondensator
Condensateur au polyester, type plat
Condensador polyester, tipo de placas planas
} 250 V

Ceramic capacitor, "pin-up"
Keramikkondensator "Pin-up" (Perltyp)
Keramische kondensator "Pin-up" type
Condensateur céramique, type perle
Condensador cerámico, versión "colgable"
} 500 V

Paper capacitor
Papierkondensator
Papierkondensator
Condensateur au papier
Condensador de papel
} 1000 V

"Microplate" ceramic capacitor
Miniatur-Scheibenkondensator
"Microplate" keramische kondensator
Condensateur céramique "microplate"
Condensador cerámico "microplaca"
} 30 V

Wire-wound trimmer
Drahttrimmer
Draadgewonden trimmer
Trimmer à fil
Trimmer bobinado

Mica capacitor
Glimmerkondensator
Micakondensator
Condensateur au mica
Condensador de mica
} 500 V

Tubular ceramic trimmer
Rohrtrimmer
Buisvormige keramische trimmer
Trimmer céramique tubulaire
Trimmer cerámico tubular

For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.
Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.
Voor universele en standaardonderdelen raadpiege men de PHILIPS Service Catalogus
Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.
Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

RESISTORS

Item	*Ordering number*	*Value*	*%*	*W*	*Description*
R1	4822 101 20341	4.7 kΩ			Potentiometer lin.
R2	4822 101 20273	1 kΩ			Potentiometer lin.
R3	4822 101 20274	220 kΩ			Potentiometer lin.
R4	4822 101 20275	100 kΩ			Potentiometer lin.
R5	4822 101 20276	1 MΩ			Potentiometer lin.
R28	4822 116 50279	999 kΩ	1	1/8	Carbon
R29	4822 111 20018	1 kΩ	1	1/4	Carbon
R31	4822 116 50046	990 kΩ	1	1/8	Carbon
R32	4822 116 50118	10.1 kΩ	1	1/4	Carbon
R33	4822 116 50197	400 kΩ	1	1/8	Carbon
R34	4822 116 50017	111 kΩ	1	1/8	Carbon
R37	4822 116 50431	1.44 kΩ	1/4	1/8	Metal film
R38	4822 116 50432	480 Ω	1/4	1/8	Metal film
R39	4822 116 50153	160 Ω	1/4	1/8	Metal film
R41	4822 116 50433	3.39 kΩ	1/4	1/8	Metal film
R42	4822 116 50383	1.13 kΩ	1/4	1/8	Metal film
R43	4822 116 50434	377 Ω	1/4	1/8	Metal film
R53, R64	4822 116 50118	10 kΩ	1	1/8	Carbon
R57	4822 116 50157	2.4 kΩ	1/4	1/8	Metal film
R61	4822 116 50539	68 Ω	1	1/8	Carbon
R63	4822 100 10059	220 Ω		0.1	Potentiometer lin.
R68	4822 100 10038	470 Ω		0.1	Potentiometer lin.
R69	4822 116 50158	5.1 kΩ	1	1/8	Carbon
R72, R89	4822 110 30187	1 MΩ	1	1/4	Carbon
R77	4822 101 20242	100 kΩ		0.1	Potentiometer lin.
R81	4822 101 20277	2.2 kΩ		0.1	Potentiometer lin.
R84	4822 116 50118	10 kΩ	1/4	1/8	Metal film
R91	4822 116 50435	226 Ω	1/4	1/8	Metal film
R92	4822 116 50119	12 kΩ	1/4	1/8	Metal film
R113	4822 100 10037	1 kΩ		0.1	Potentiometer lin.
R203	4822 116 20093		10	0.8	Volt. dep. resistor.
R220	4822 100 10023	470 Ω	20	0.1	Potentiometer lin.
R226	4822 116 50119	12 kΩ	1/4	1/8	Metal film
R231	4822 116 50118	10 kΩ	1	1/8	Carbon
R233, R234	4822 116 50102	2.2 kΩ	1	1/8	Carbon
R243	4822 116 50079	680 Ω	1	1/8	Carbon
R244	4822 111 20296	16 kΩ	1	1/8	Carbon
R247	4822 116 50207	6.2 kΩ	1	1/8	Carbon
R251	4822 111 20019	3 kΩ	1	1/8	Carbon
R257	4822 116 50009	11 kΩ	1	1/8	Carbon

Item	*Ordering number*	*Value*	*%*	*W*	*Description*
R266, R307	4822 100 10029	2.2 kΩ		0.1	Potentiometer lin.
R270	4822 116 30018	1.3 kΩ		1	Neg. temp. coeff.
R271	4822 100 10036	4.7 kΩ		0.1	Potentiometer lin.
R274	4822 111 20275	137 kΩ	1	⅛	Carbon
R276	4822 111 20297	49 kΩ	1	⅛	Carbon
R277	4822 111 20298	19.5 kΩ	1	⅛	Carbon
R278	4822 111 20299	4.9 kΩ	1	⅛	Carbon
R279	4822 111 20231	406 Ω	1	⅛	Carbon
R282	4822 111 20302	211 kΩ	1	⅛	Carbon
R283	4822 111 20022	3.9 kΩ	1	⅛	Carbon
R289	4822 116 50118	10 kΩ	1	⅛	Carbon
R291	4822 116 50118	10 kΩ	1	⅛	Carbon
R299, R314	4822 116 20083				Volt. dep. resistor
R329	4822 100 10079	47 kΩ		0.1	Potentiometer lin.
R295, R332	4822 100 10052	100 kΩ		0.1	Potentiometer lin.
R406	4822 113 60056	1 Ω	10	1	Wire wound
R407	4822 116 30064	15 Ω		1	Neg. temp. coeff.
R411	4822 100 10029	2.2 kΩ		0.1	Potentiometer lin.
R414	4822 116 30058	1.3 kΩ		1	Neg. temp. coeff.

CAPACITORS

Item	*Ordering number*	*Value*	*%*	*W*	*Description*
C26	4822 121 40145	0.1 µF	10	630	Plate
C27, C29 C32, C34 C37, C39	4822 125 60027	6 pF		400	Trimmer
C31	4822 120 60107	1000 pF	1	500	Mica
C36	4822 120 60087	180 pF	1	500	Mica
C51	4822 121 40088	0.01 µF	10	250	Polyester
C53	4822 124 20405	400 µF		4	Electrolytic
C59	4822 124 20402	250 µF		16	Electrolytic
C63	4822 124 20362	20 µF		16	Electrolytic
C66	4822 124 20032	4 µF		250	Electrolytic
C67	4822 124 20402	250 µF		16	Electrolytic
C68	4822 124 20403	400 µF		10	Electrolytic
C202	4822 121 40061	0.22 µF		250	Polyester
C203	4822 124 20362	20 µF		16	Electrolytic

Item	*Ordering number*	*Value*	*%*	*W*	*Description*
C204, C228	4822 124 20344	2.5 µF		16	Electrolytic
C206	4822 124 20402	250 µF		16	Electrolytic
C208, C209, C210	4822 124 20362	20 µF		16	Electrolytic
C212, C218	4822 124 20362	20 µF		16	Electrolytic
C215	4822 121 40123	0.015 µF		1600	Polyester
C226	4822 124 20395	200 µF		10	Electrolytic
C229	4822 124 10087	15 µF		35	Tantalum
C231	4822 121 50275	0.15 µF	1	63	Polyester
C232	4822 121 50281	0.015 µF	1	63	Polyester
C234	4822 121 50189	1300 pF	1	250	Polyester
C236	4822 120 60082	110 pF	1	500	Mica
C237	4822 125 50018	18.5 pF		50	Trimmer
C244	4822 124 20362	20 µF		16	Electrolytic
C236	4822 121 40195	0.033 µF	10	1600	Polyester
C327	4822 121 40088	0.01 µF	10	250	Polyester
C401	4822 124 40003	1600 µF		40	Electrolytic
C402	4822 124 20359	16 µF		40	Electrolytic
C403	4822 124 20344	2.5 µF		16	Electrolytic
C404	4822 124 20394	160 µF		25	Electrolytic
C405	4822 121 50331	6200 pF	1	500	Polyester
C406	4822 124 20032	4 µF		250	Electrolytic
C407	4822 124 20029	25 µF		300	Electrolytic
C408	4822 124 20042	32 µF		100	Electrolytic
C409, C411	4822 124 20406	400 µF		16	Electrolytic
C412, C413	4822 121 40196	0.022 µF	10	1600	Polyester

COILS

L26, L202	4822 526 10025		Ferroxcube bead
L201	4822 158 10052		Coil
L401	4822 158 30132	2x0.73 mH	Coil
L402	4822 158 20234	427 mH	Coil
L403	4822 158 20235	50 mH	Coil
L404	4822 158 20236	2.23 mH	Coil
L406	4822 158 20237	8.5 mH	Coil

TUBES, TRANSISTORS, RECTIFIERS

Type	*Ordering number*	*Item*
ECC 83		B26
D10-16GH		B326
AAZ 13	4822 130 30231	GR206...GR208
BA 114	4822 130 30189	FR203, GR402
BA 148	4822 130 30256	GR406...GR412
BY 122	4822 130 30261	GR401
BYX 10	4822 130 30195	GR404, GR413...GR418
BZY 58	4822 130 30324	GR202
BZY88/C8V2	4822 130 30285	GR403
OA 95	4822 130 30191	GR26, GR27 GR200, GR201, GR204, GR209
OA 202	4822 130 30239	GR28, GR29, GR31, GR32 GR205, GR326
AC 187	4822 130 40314	TS217, TS408, TS409
AC 188	4822 130 40456	TS406, TS407
BC 147	4822 130 40311	TS401, TS403
BC 149	4822 130 40313	TS219, TS221
BC 177	4822 130 40354	TS222, TS226
BC 178B	4822 130 40348	TS404
BCY 87*	4822 130 40423	TS32', TS32"
BDY 38	4822 130 40524	TS402
BF 115	4822 130 40308	TS38, TS41, TS208, TS209
BF 173	4822 130 40326	TS34, TS36, TS37, TS39 TS42... TS46
BF 179	4822 130 40661	TS223, TS224, TS227, TS228
BF 194	4822 130 40303	TS26...TS31, TS47, TS201... TS206, TS207, TS211, TS212 TS214, TS216
BSY 38A	4822 130 40138	TS213
FW 5198 (Fairchield)	4822 130 40195	TS204, TS218
GL 8 (Neon lamp)	4822 134 20016	LA1

* BCY 87 When replacing this double transistor, first see chapter XI. REPLACING PARTS, point E.

C. PARTS OF THE PROBES (Fig. 12)
PM 9326 AND PM 9327

Item	*Qty*	*Ordering number*	*Description*
a	1	4822 320 10042	Probe cabe 2 m (6.5') for PM 9327
	1	4822 321 20087	Probe cable 1.15 m (3.8') for PM 9326
b	1	4822 321 20096	Earthing flex 15 cm (6")
c	1	4822 321 20134	Earthing flex 30 cm (12")
d	1	4822 266 20015	Measuring probe 1 : 1 (black)
e	1	4822 268 10029	Measuring pin
f	1	4822 268 10039	Measuring hook
g	1	4822 210 70044	Attenuator probe 1 : 10 (grey)
h	1	4822 264 20009	Measuring clip
	1	4822 111 20155	Resistor

XV Version for television service PM 3200X

This instrument, the PM 3200 with the addition of a synchronisation-separator, facilitates triggering on the line pulses or frame pulses of television signals.

Deviations of the PM 3200X with respect to the PM 3200 are given in the following section.

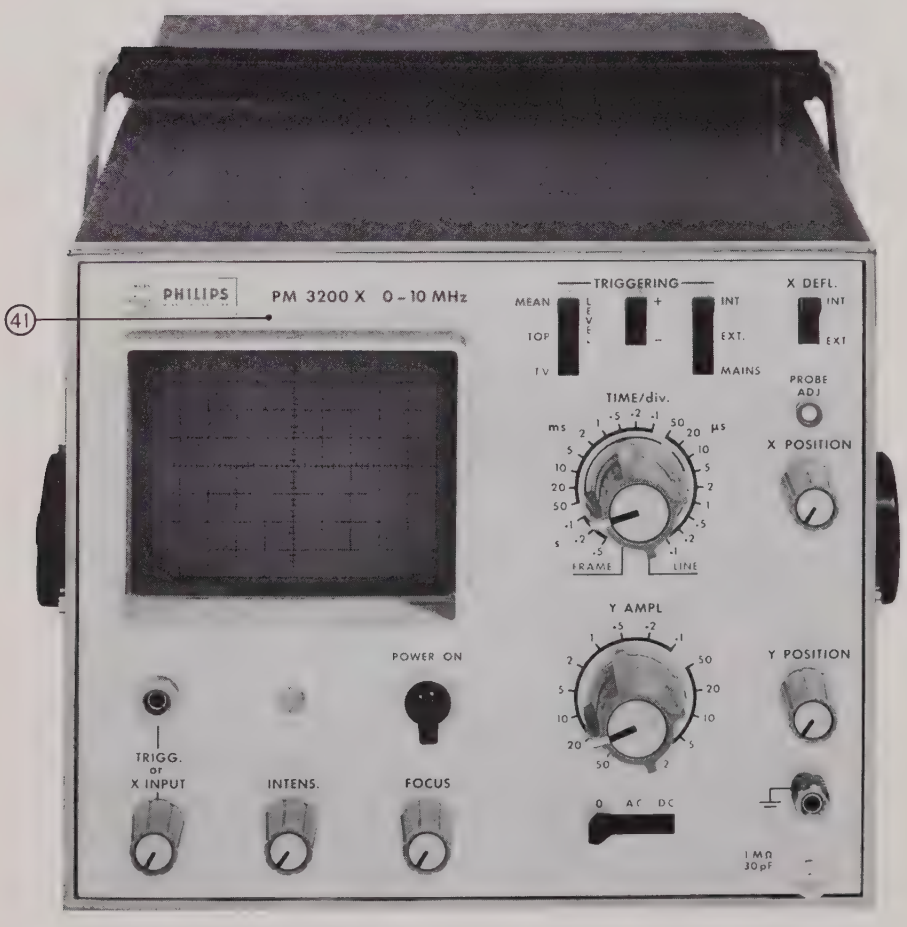


Fig. 23. Front view of PM 3200X

MA 5478

TECHNICAL DATA

Identical to those of the PM 3200 except for triggering level.
Position "HF rej." of switch LEVEL is replaced by position "TV". If switch LEVEL is in position "TV", a synchronisation-separator is activated in the trigger circuit. It is then possible to trigger internally on the line and frame synchronizing pulses of a television signal. Triggering on the frame synchronizing pulses is possible in the positions 5 sec... 50μsec (TV FRAME) of time base switch TIME/div and triggering on line pulses is possible in the positions 20 μsec... 0.1 μsec (TV LINE)

OPERATION, section TRIGGERING

Triggering in positions "MEAN" and "TOP" of switch LEVEL takes place in the same way as in the PM 3200.
Triggering on television signals is as follows:

- Supply TV-signal to be visualized to Y-input.
- Set switch LEVEL in position "TV".
- Set switch +/– in position +, if the signal has positive going synchronizing pulses (thus a negative videosignal), and in position –, if the signal has negative going synchronizing pulses.
- Set switch INT-EXT-LINE on INT.
- Set switch X-DEFL on INT.
- Set time base switch TIME/div in one of the positions marked "TV FRAME" when triggering on frame pulses and in one of the positions marked "TV LINE" when triggering on line pulses is required.

CIRCUIT DIAGRAM DESCRIPTION

The circuit diagram is identical to that of the PM 3200 except for the synchronisation-separator. (Printed circuit board, Unit 6, Fig. 28). The diagram for the latter is given in a different colour in Fig. 32.
The videosignal is supplied to the synchronisation-separator consisting of TS352 and GR351 via emitter follower TS 351.
The TV-signal is clipped in such way that only the synchronizing pulses occur on the collector of TS532. In the positions TV LINE these pulses are supplied directly to the time base generator. In positions TV FRAME the composite synchronizing signal is integrated by means of R357, C354, GR352, R359, and C356 with such a time constant that the frame pulses are separated.
These separated pulses are supplied to the time base generator via emitter follower TS353. The emitter follower ensures that the integrator is loaded

to a minimum. Superposition as a result of cross-talk of line pulses on the integrated frame pulses via contacts of switch SK10 is prevented by means of R356 and C353.

LIST OF PARTS

A. MECHANICAL

The list of mechanical parts is the same as that of the PM 3200 except for another text plate and a few additions. When the time base switch has to be replaced the spindle of the X-version has to be used in item 25 of the PM 3200.

Item	*Fig.*	*Qty*	*Order no.*	*Description*
39	20	1	4822 216 50141	Printed circuit (Unit 6)
40	20	1	4822 277 20022	Microswitch (SK10)
41	23	1	4822 455 80053	Text plate

B. ELECTRICAL

For the PM 3200X the parts GR200, C207 and R216 are omitted from the list of electrical parts of the PM 3200.
The following parts are added.

Capacitors

Item	*Ordering number*	*Value*	*V*	*Description*
C351	4822 124 20362	20 µF	16 V	Electrolytic
C352	4822 124 20351	6,4 µF	25 V	Electrolytic
C357	4822 124 20362	20 µF	16 V	Electrolitic

Semi-conductors

Item	*Ordering number*	*Type*	*Description*
GR351	4822 130 40182	BAX13	Diode
GR352	4822 130 40182	BAX13	Diode
TS351	4822 130 40311	BC147	Transistor
TS352	4822 130 40311	BC147	Transistor
TS353	4822 130 40313	BC149	Transistor

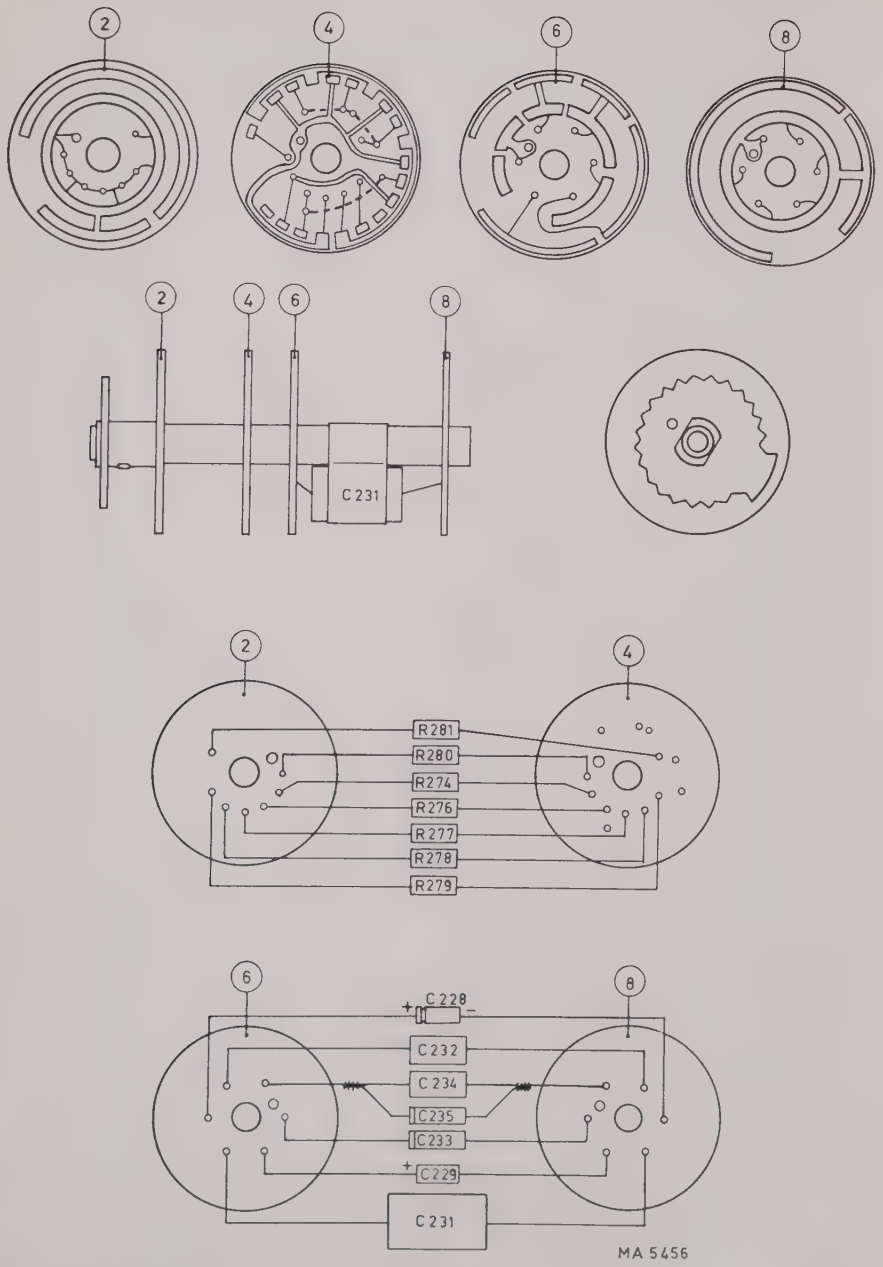


Fig. 24. Switch turret, unit 2 (Time div.)

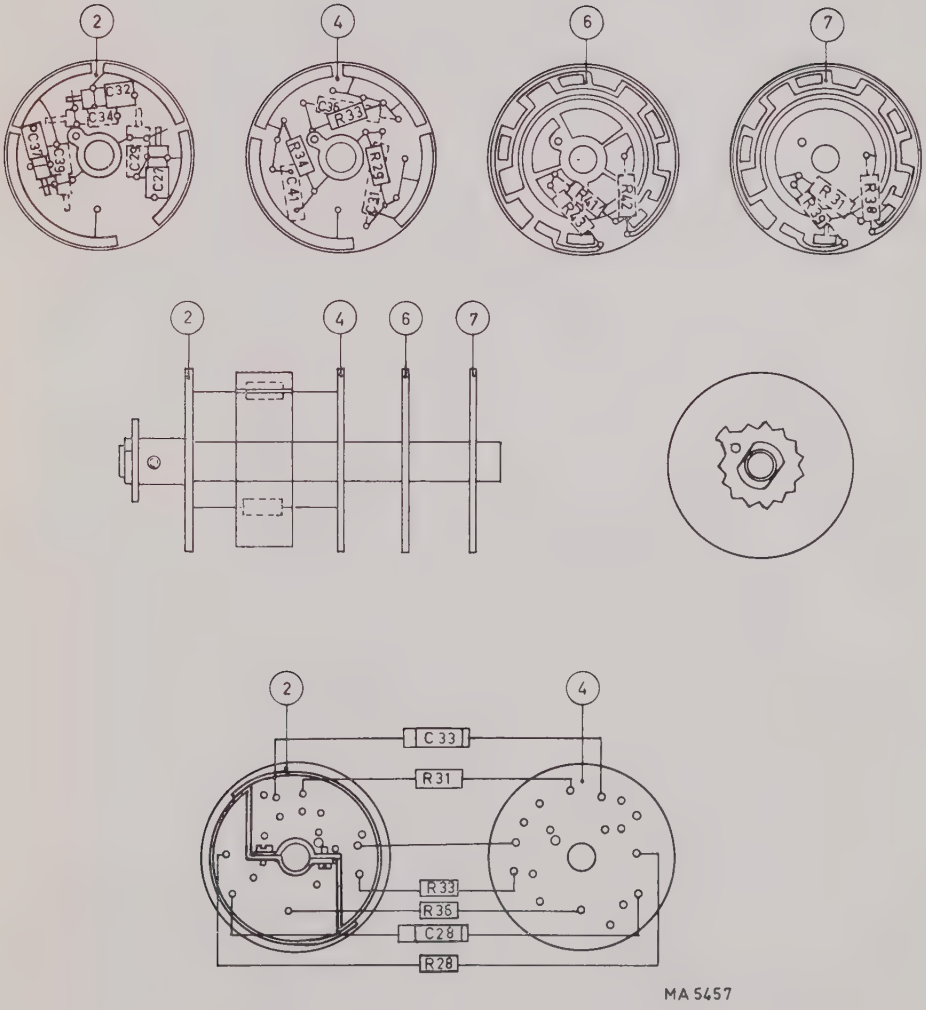
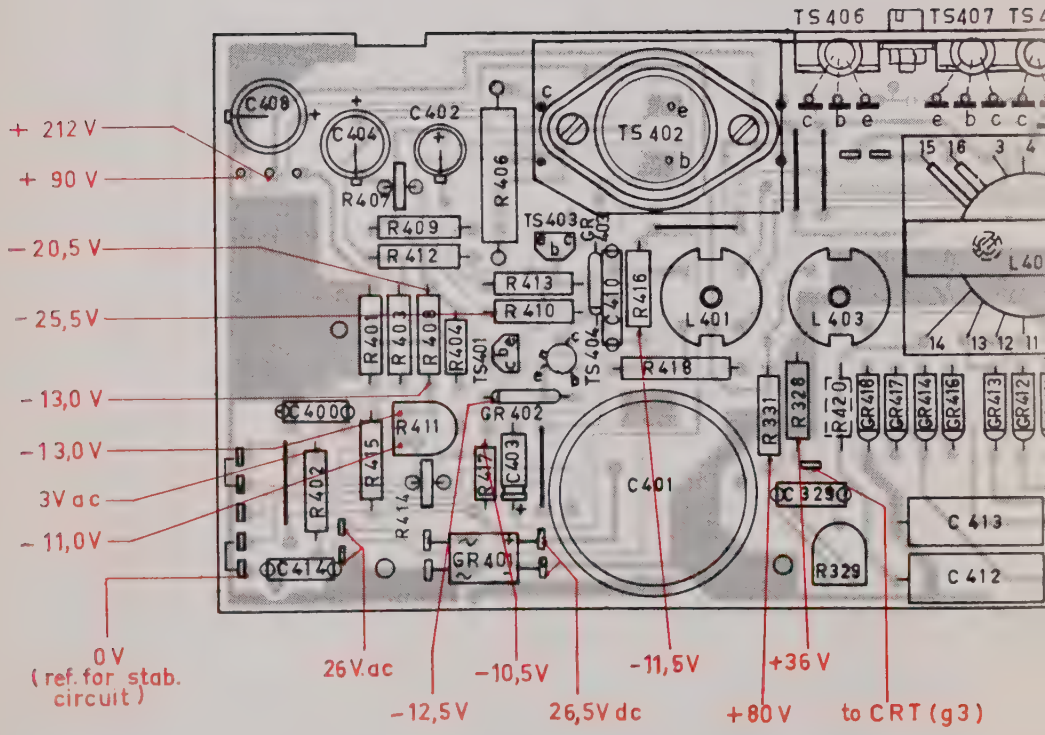


Fig. 25. Switch, turret, unit 3 (Volt/div)


+ 212 V
+ 90 V
– 20,5 V
– 25,5 V
– 13,0 V
– 13,0 V
3V ac
– 11,0 V
0 V
(ref. for stab. circuit)
26 V ac
– 12,5 V
– 10,5 V
26,5 V dc
– 11,5 V
+ 80 V
+ 36 V
to CRT (g3)
TS406
TS407
TS402
TS403
TS401
TS404
C408
C404
C402
C400
C401
C410
C403
C414
C413
C412
C329
R406
R407
R409
R412
R413
R410
R401
R403
R408
R404
R411
R415
R402
R414
R417
R416
R418
R331
R328
R420
R329
GR402
GR401
GR403
GR418
GR417
GR414
GR416
GR413
GR412
L401
L403
L40

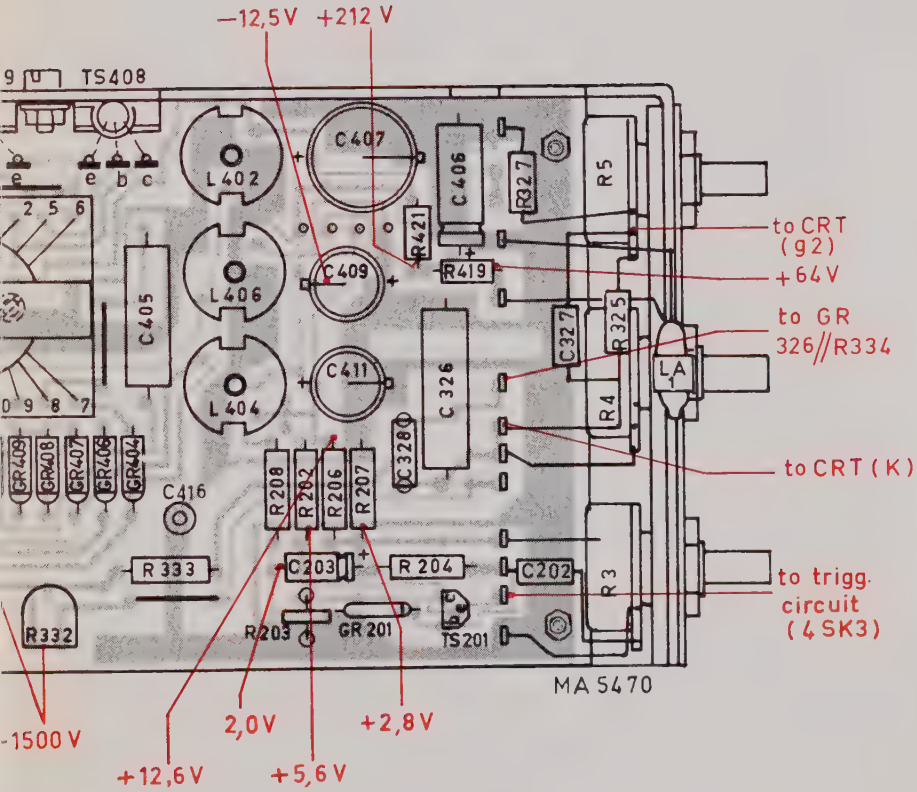
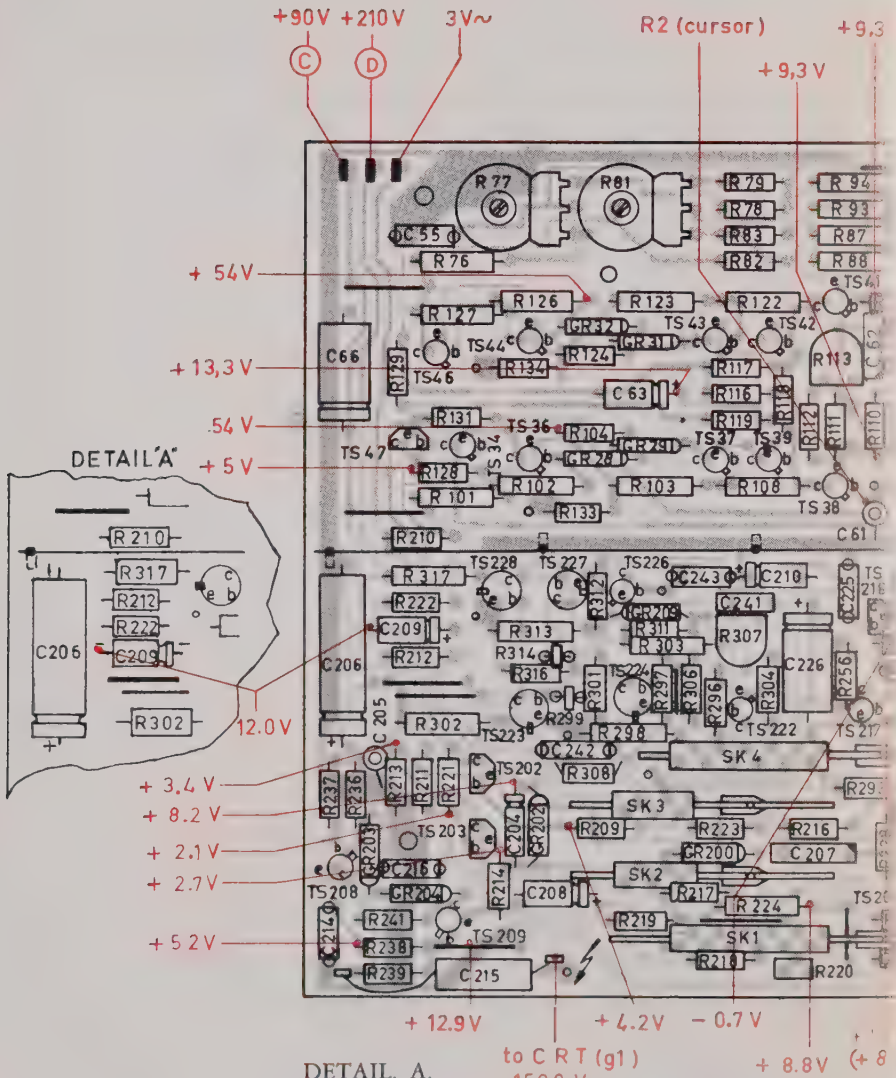


Fig. 26. Printed circuit board, unit 4 (power supply)



DETAIL. A.
This detail shows the lay-out of the components in instrument of the series PM3200/03 with code-letter C behind the serial number, where it differs from that in instruments of the series PM3200/04.

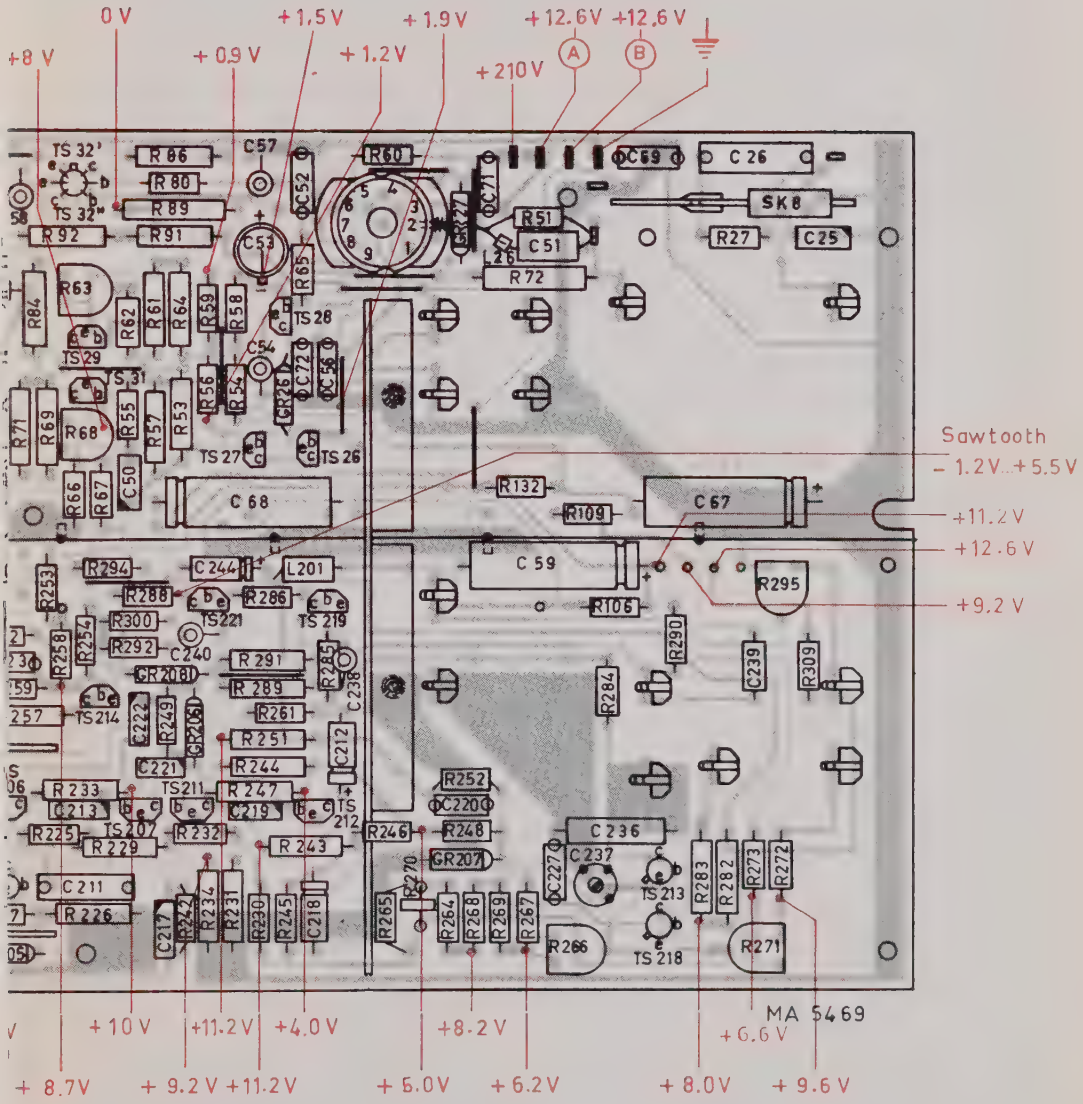


Fig. 27. Printed circuit board, unit 5 (Y-amplifier; time base)

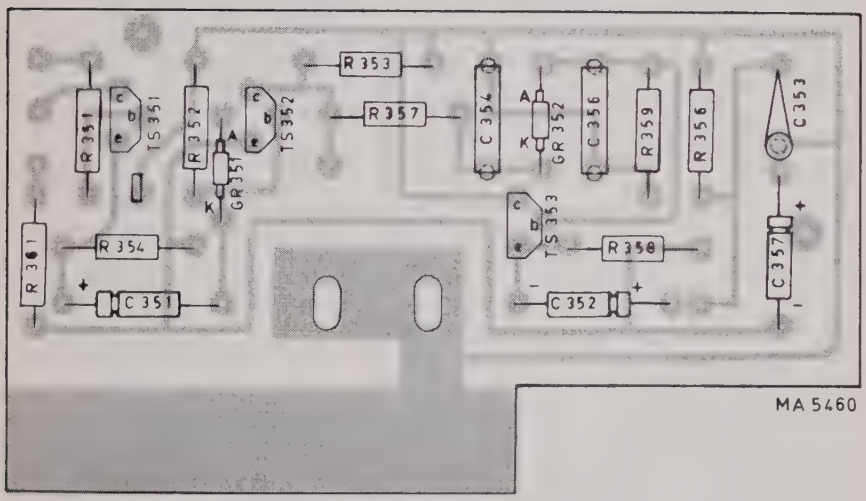
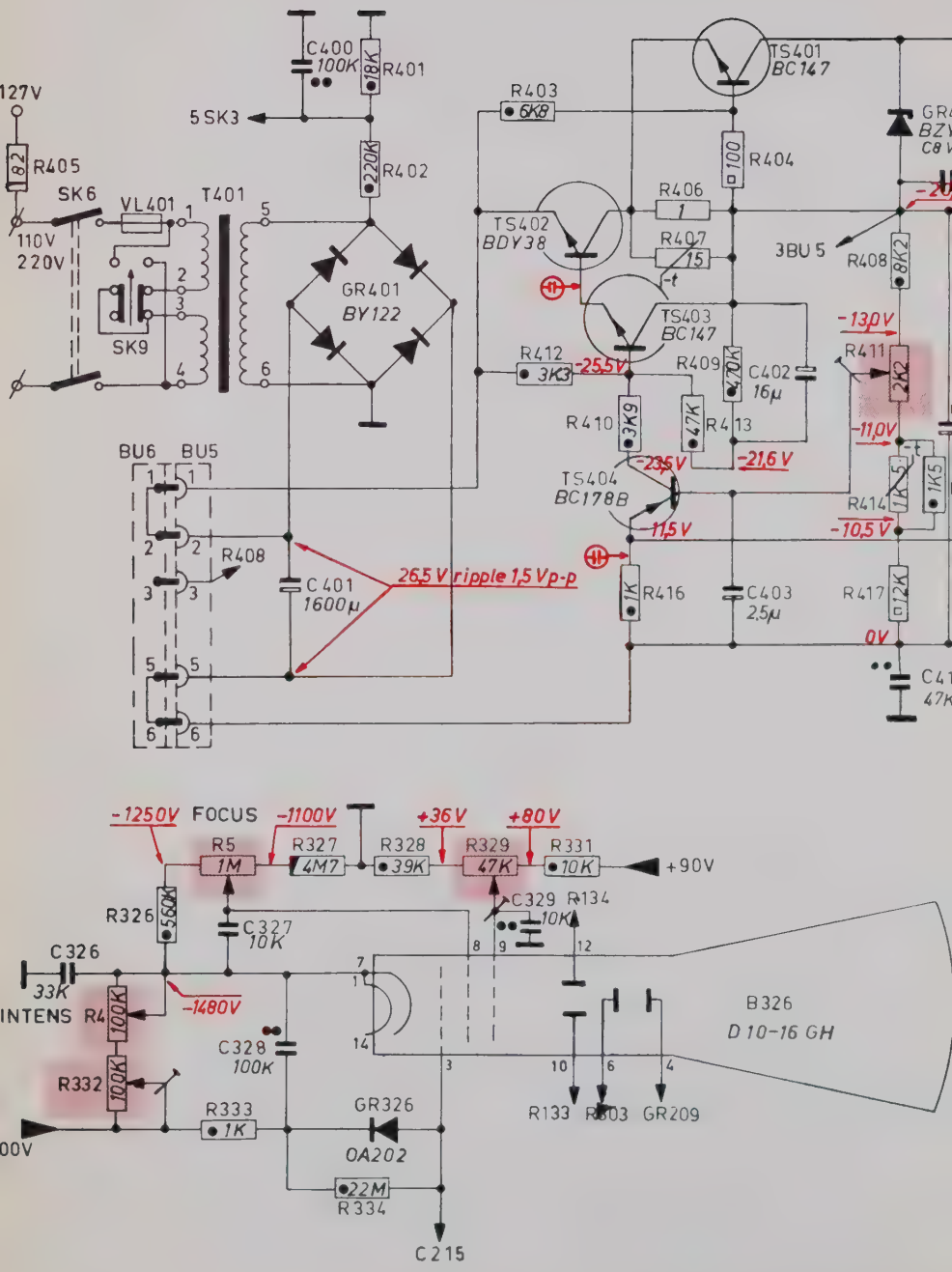


Fig. 28. Printed circuit board unit 6 (synchronisation separator)


127V
182
R405
SK6
110V
220V
VL401
T401
SK9
5SK3
C400
100K
18K
R401
220K
R402
GR401
BY122
BU6
BU5
R408
C401
1600µ
26,5 V ripple 1,5 Vp-p
R403
6K8
TS401
BC147
100
R404
R406
1
TS402
BDY38
R407
15
TS403
BC147
3BU5
R408
8K2
-13,0V
R412
3K3
-25,5V
R409
4,70K
C402
16µ
R411
2K2
-11,0V
R410
3K9
47K
R413
-21,6 V
-23,5V
TS404
BC178B
-11,5V
R414
1K5
1K5
-10,5V
R416
1K
C403
2,5µ
R417
0,12K
0V
C41
47K
-1250V
FOCUS
-1100V
+36V
+80V
R5
1M
R327
4M7
R328
39K
R329
47K
R331
10K
+90V
R326
560K
C327
10K
C329
10K
R134
C326
33K
INTENS R4
100K
-1480V
R332
100K
C328
100K
R333
1K
GR326
OA202
22M
R334
C215
B326
D 10-16 GH
R133
R303
GR209
00V

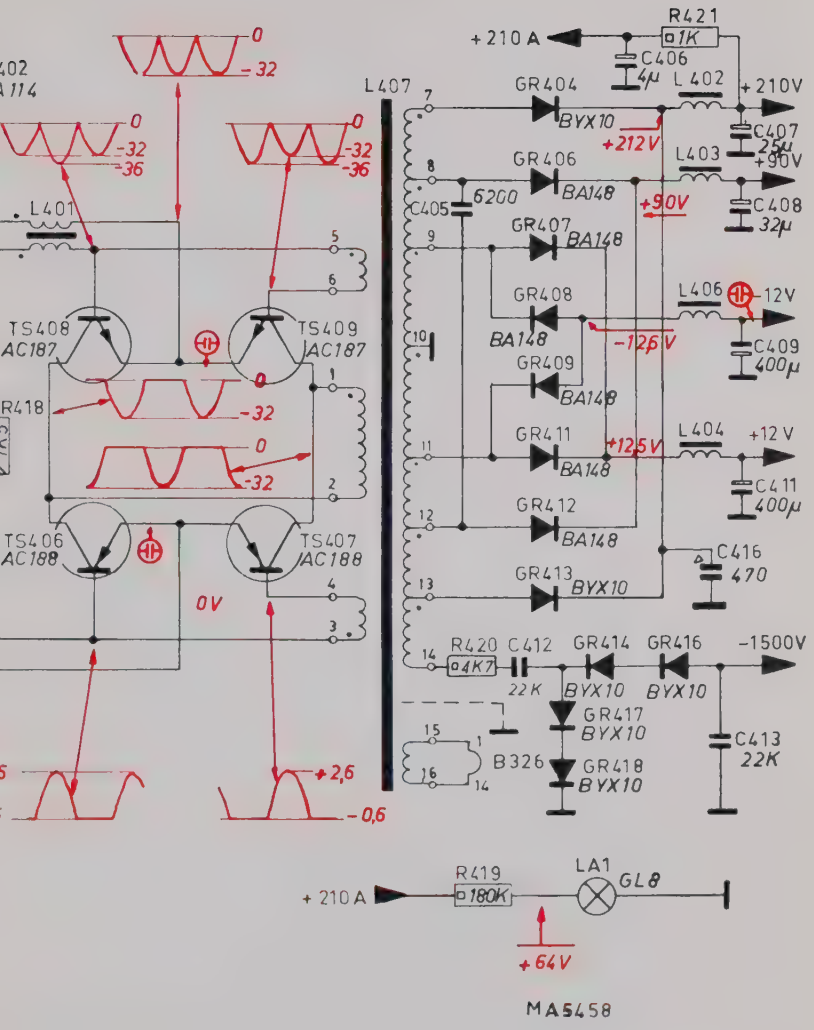
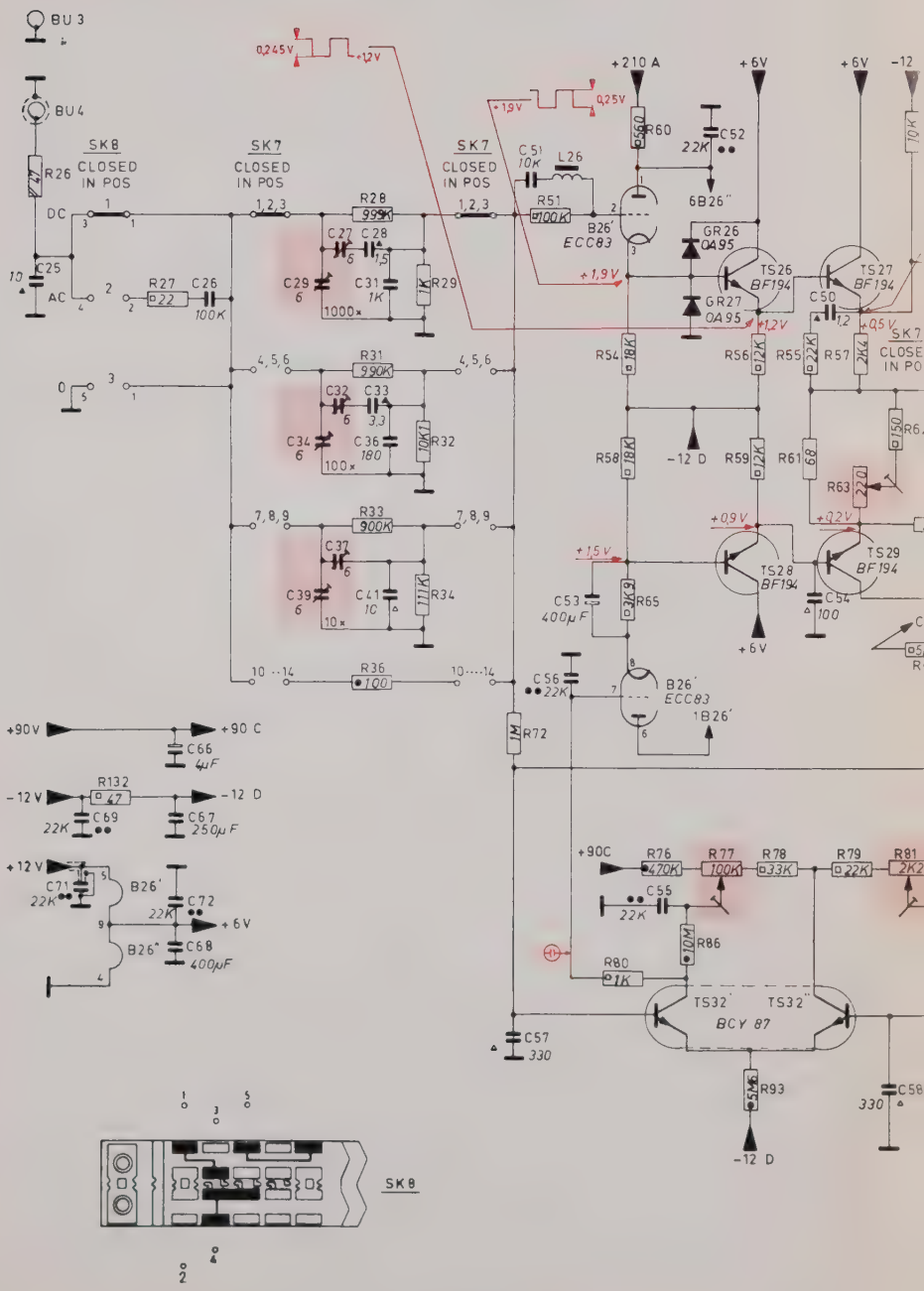


Fig. 29. Circuit diagram of power supply +CRT circuit


BU 3
BU 4
SK8 CLOSED IN POS
SK7 CLOSED IN POS
SK7 CLOSED IN POS
R26 47
C25 10
R27 22
C26 100K
R28 999K
C27 6
C28 1,5
C29 6
C31 1K
R29 1K
1000×
R31 990K
C32 6
C33 3,3
C34 6
C36 180
100×
R32 10K
R33 900K
C37 6
C39 6
C41 1C
R34 111K
10×
R36 100
C51 10K
L26
R51 100K
B26' ECC83
+210 A
R60 560
C52 22K
6B26"
GR26 OA95
GR27 OA95
TS26 BF194
TS27 BF194
C50 12
+6V
-12
10K
+1,9V
+1,2V
+0,5V
R54 18K
R56 12K
R55 22K
R57 2K2
R58 18K
-12 D
R59 12K
R61 68
R63 220
R64 150
+0,9V
+0,2V
+1,5V
TS28 BF194
TS29 BF194
C53 400µF
R65 3K9
C54 100
+6V
C56 22K
B26' ECC83
1B26'
1M R72
+90V
+90 C
C66 4µF
R132 47
-12 V
-12 D
C69 22K
C67 250µF
+12 V
C71 22K
B26'
C72 22K
+6V
B26"
C68 400µF
+90C
R76 470K
R77 100K
R78 33K
R79 22K
R81 2K2
C55 22K
R86 10M
R80 1K
TS32' TS32"
BCY 87
C57 330
R93 5M6
-12 D
C58 330
SK8

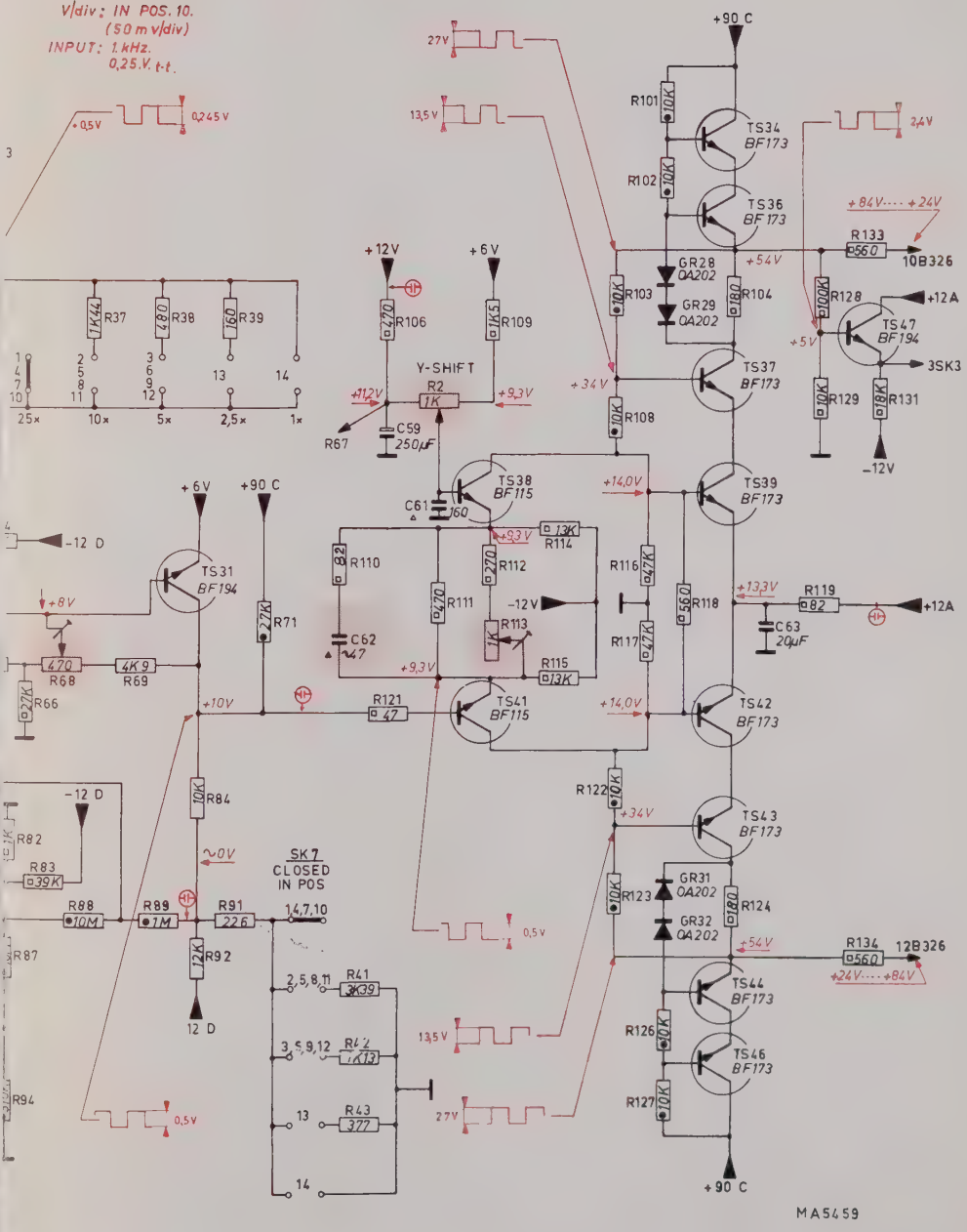


Fig. 30. Circuit diagram of attenuator + Y-amplifier

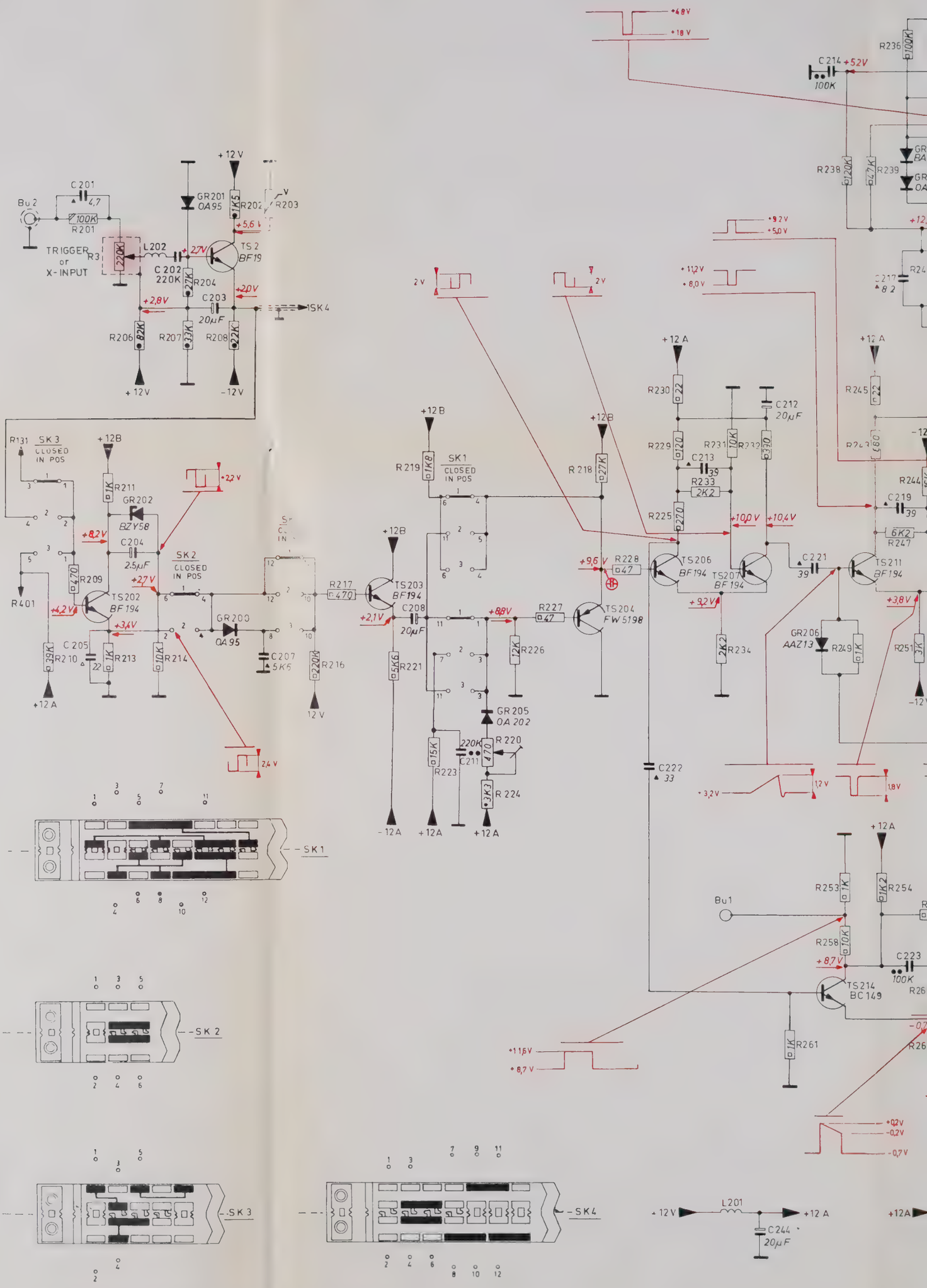


Fig. 31. Circuit diagram of trigger amplifier + time base generator + beam control + X-amplifier
L 202 for PM 3200/04 only

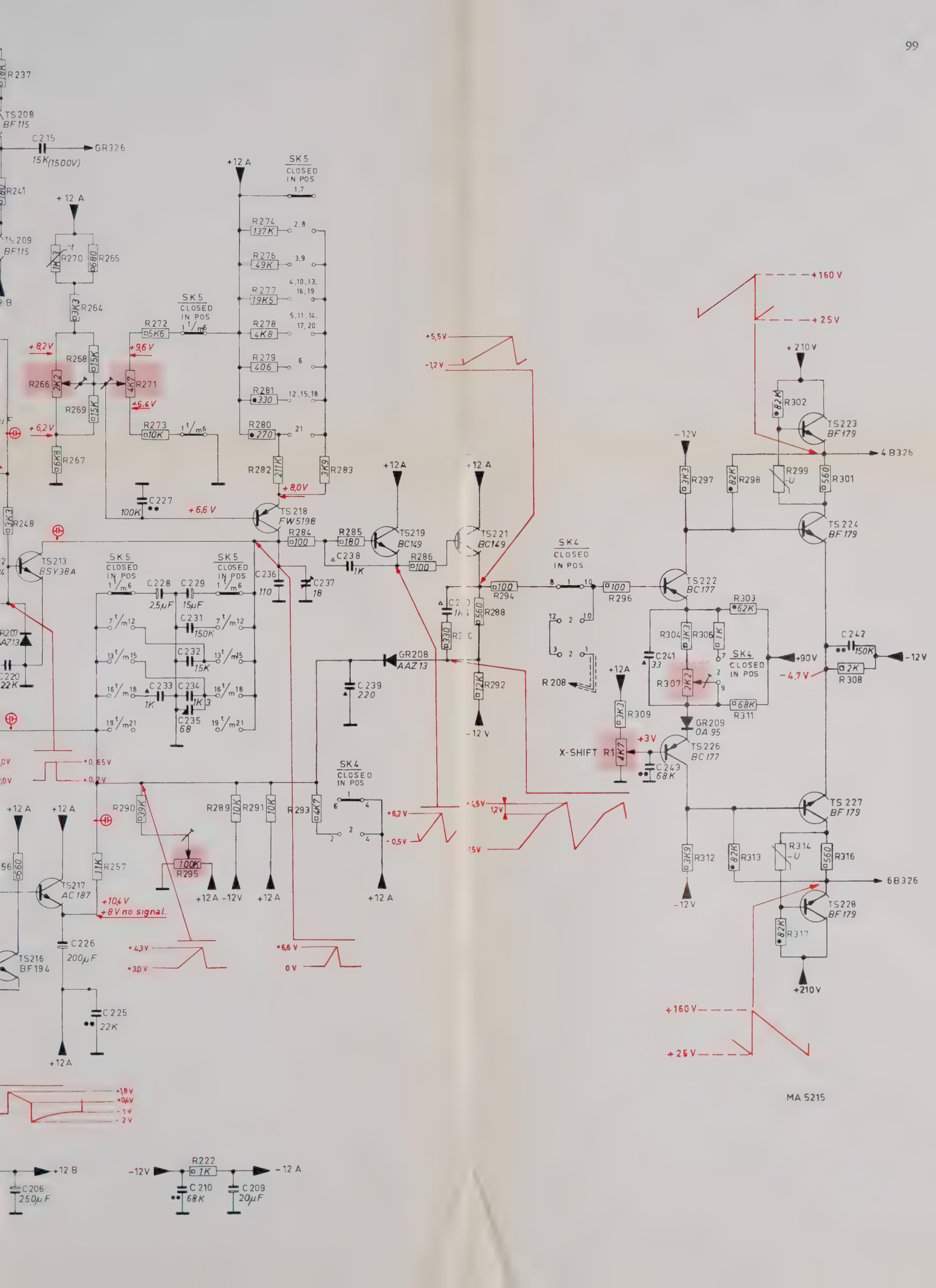

R237
TS208 BF 115
C215 15K(1500V)
GR326
+12 A
SK5 CLOSED IN POS
R241
TS209 BF115
R270
R265
R264
R274 137K
R276 49K
R277 19K5
R278 4K8
R279 406
R281 330
R280 270
R272 5K6
R273 10K
R268
R269
R266 2K2
R271 4K7
R267 6K8
R282 211K
R283 3K9
+8,2V
+9,6V
+6,6V
+6,2V
+8,0V
C227 100K
TS218 FW5198
R248
TS213 BSY38A
R284 100
R285 180
TS219 BC149
C238 1K
R286 100
TS221 BC149
C236 110
C237 18
C228 2,5µF
C229 15µF
C231 150K
C232 15K
C233 1K
C234 1K
C235 68
GR208 AAZ13
C239 220
R288 560
R294 100
R296 100
R292 12K
R208
-12 V
+5,5V
-12V
+0,65V
+0,2V
R290 39K
R289 10K
R291 10K
R293 4K7
100K R295
R257 1K
TS217 AC187
+10,4 V
+8 V no signal
C226 200µF
TS216 BF194
C225 22K
+4,3V
+3,0V
+6,6 V
0 V
+6,2 V
-0,5V
+4,5V
12V
15V
+1,8 V
+0,4V
-1 V
-2 V
+12 B
C206 250µF
-12V
R222 1K
C210 68K
C209 20µF
-12 A
+160 V
+25 V
+210 V
R302 82K
TS223 BF179
4 B326
R297 3K3
R298 82K
R299 -U
R301 560
TS224 BF179
TS222 BC177
R303 62K
R304 3K3
R306 1K
C241 33
R307 2K2
SK4 CLOSED IN POS
+90V
-4,7V
C242 150K
R308 2K
-12V
R309 3K3
GR209 OA 95
+3V
X-SHIFT R1 4K7
TS226 BC177
C243 68K
R311 68K
TS 227 BF 179
R312 3K9
R313 82K
R314 -U
R316 560
6 B326
TS228 BF179
R317 82K
+210V
+160 V
+25 V
MA 5215

Fig. 32. Circuit diagram of trigger amplifier + time base generator + beam control + X-amplifier PM 3200X + synchronisation separator

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